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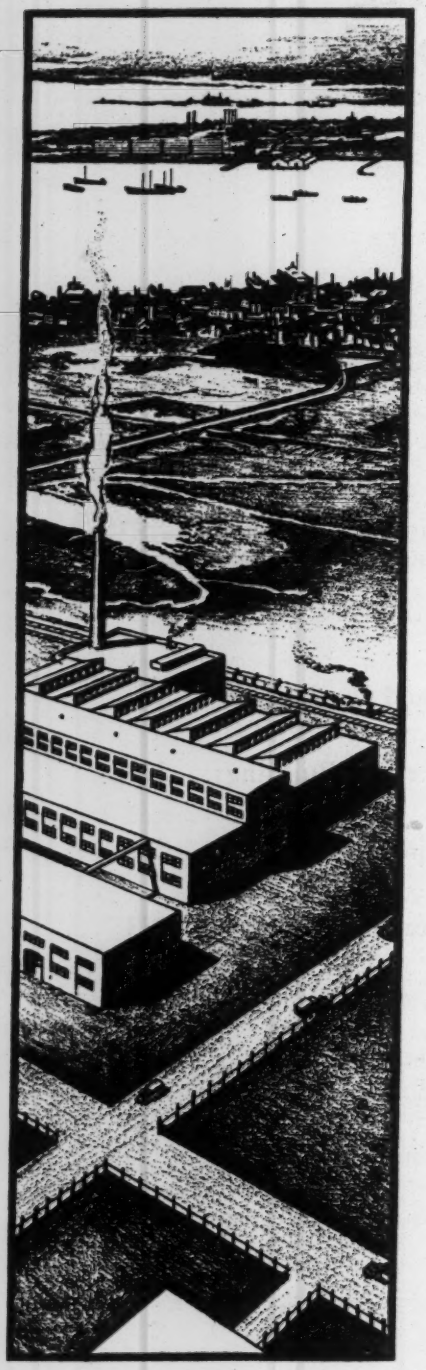

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Timber Highway Bridges in Oregon

Economic factors studied and grading rules improved—Design and architectural treatment reviewed—Fire danger and high moisture changes point to use of concrete deck

By C. B. McCullough
Bridge Engineer, Oregon State Highway Commission

THE FEASIBILITY of extending the use of timber for modern highway-bridge construction has been a subject of recent economic and technical study by the Oregon state highway commission. The primary purpose of the investigation has been to restudy the fundamentals of timber construction for modern highway use with a view to effecting economies. A secondary purpose has been the possibility of aiding the leading industry of the state. Results to date include the preparation of an especially rigid specification for timber grading, improvements in design, particularly in reference to details of decking, and the development of a more suitable architectural treatment. An approach to the problem was made by enumerating the inherent defects known to exist in present timber-bridge construction and then studying means for improvement.

Fig. 1—Initial example of improved architecture in small timber bridges in Oregon.

A basic improvement to be made in bettering all types of timber construction is in the selection of the individual pieces of material. Although considerable progress has been made recently in the standardization of grading, particularly for structural timbers, the present study showed that formulation of a separate specification for bridge timbers was advisable. This short set of specifications for structural timber, distinct from the regular specifications of the department, covers the grading requirements for all bridge-timber purchase orders. Using as a standard the grading rules of the West Coast Lumbermen's Association (*ENR*, July 31, 1930, p. 169), the specification determines the grade to be used for various members of a structure and states the allowable percentage of heart wood. Requirements for heart wood are: caps, posts and sills, 75 per cent on each face; beams, stringers and truss members, 85 per cent on each face; laminated or grooved decking, 90 per cent on each face. Further, special attention is directed to freedom from end-checking, and the inspector at the mill is required to coat the ends of sticks with oil immediately upon acceptance. All lumber and timber must bear either a standard grade mark or have a certificate of inspection from an approved inspection agency.

The provisions of grading and inspection contained in the new specifications are believed to be the most rigid ever written for structural timber, although applying only to Douglas fir. Primary

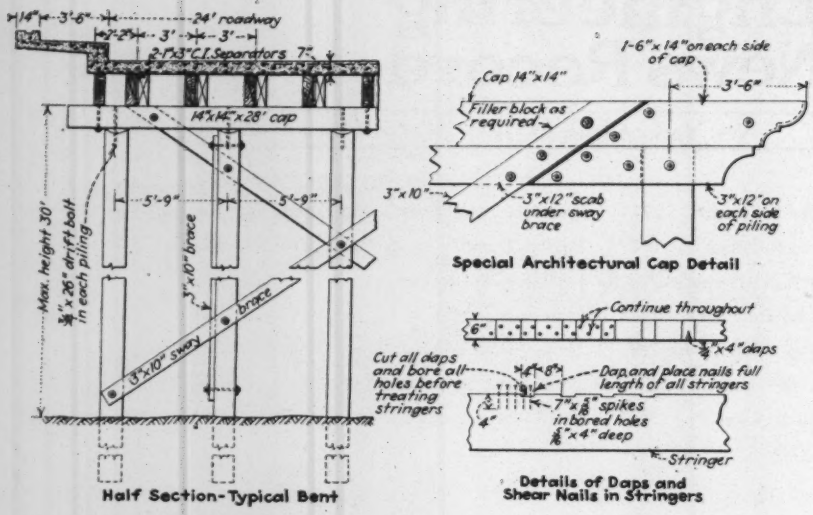
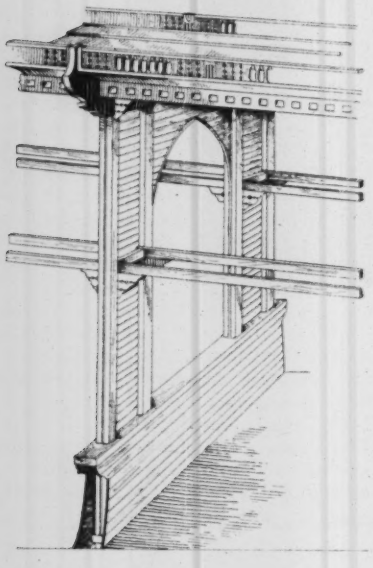


Fig. 2—Details of improved timber-trestle construction designed for better utilization of material. Note the swaybracing on inside lines of piles and the special architectural treatment for the ends of the caps.

and secondary grades of timber are established to segregate the material desired to have the highest possible quality as distinct from the ordinary run of timber used in bridge construction. The primary or highest grade called for, which must be almost exclusively dense structural Douglas fir according to the West Coast Lumbermen's Association grading rules, is expensive timber, but it is believed to be justified if the purpose of the study is to be accomplished in developing an improved type of timber-bridge construction. In general, all timber for new construction is required to be pressure-treated with creosote after being framed and bored.

Formulation of these specifications is considered the first important accomplishment in the present development.

Fig. 3—Suggested improvement of architectural lines for high timber trestle.



It is intended to provide, through a system of rigid grading and inspection, lumber of a quality much more uniform and dependable than has been available heretofore. As a result, it is hoped that much of the difficulty with checking, splitting and warping, which constitutes one of the greatest defects in timber-bridge work, will be eliminated.

Durable deck

A common problem encountered in timber-bridge construction has always been the high cost of maintaining decks and road surfaces. A solution that has been used in other Western states for several years is the use of a creosoted-timber supporting structure in conjunction with a reinforced-concrete roadway slab. This combination of materials lends itself to some interesting design possibilities. For example, the tops of the timber stringers may be dapped and provided with spikes partly set into the top of the stringer (Fig. 2) to assist in distributing the load between stringers and concrete deck. This results in producing a certain amount of tee-beam action, thus reducing stringer deflection and the cracking tendency in the concrete slab.

Another detail of design intended to provide better appearance is the placing of the upper end of the swaybracing inside the outer lines of piles. This permits better architectural treatment of the end of the caps and is of practical use in allowing a housing to be placed over the heads of the outside piles, which are the ones most exposed to the weather. The regular tower bracing of 3x10-in. members is placed on the intermediate line of piles to improve the general appearance of the structure.

Pile heads are given special treatment for protection of the cut surface before placing the caps. After three applications of hot creosote oil they are required to be coated with hot roofing pitch and a galvanized iron cover, or alternate layers of pitch and woven fabric. This cover must be larger than the pile head and be bent down over the edge and fastened with large-head nails or galvanized wire.

A further improvement in design detail consists in using a hand-railing of concrete posts and rails, with intermediate members of timber, sandblasted to expose the grain and stained brown for a more pleasing appearance.

Architectural treatment

The initial attempt to improve architectural treatment is shown in Fig. 1. This timber trestle was the first to be built in accordance with the new program. Although it is admitted that much improvement could be made on this design, it is a considerable advance

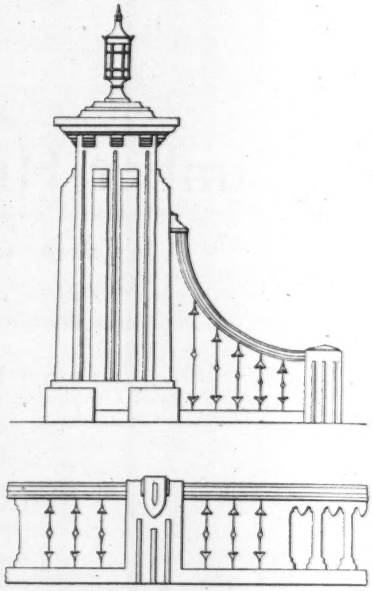


Fig. 4—One of the more elaborate architectural designs in wood developed for Oregon timber-bridge railings.

over the standard trestle type of structure. Another suggested architectural treatment of a high timber trestle frame is shown in Fig. 3, where a Swiss chalet type of corbel is used. Other suggestions and designs are under consideration such as the one illustrated in Fig. 4, both to improve the appearance of the wooden structures and also to utilize the combination of concrete and timber to the best advantage in the larger type of structures.

These studies have been carried out under the direction of the Oregon state highway commission. R. H. Baldock is state highway engineer. The writer as bridge engineer has been in direct charge of the program to improve design and extend the use of timber. Active cooperation in the work has been extended to the staff and engineers representing the National Lumber Manufacturers' Association, the West Coast Lumbermen's Association and the timber preservative industry.

Wagon-Haulage Equipment for Levee Building

Heavy tractors, large crawler wagons, power-loading elevating graders and crawler-dragline excavators have been developed into levee-building outfits of major importance

By J. C. French
Bucyrus Erie Co., South Milwaukee, Wis.

WAGON haulage, for many years the major method of building levees, continues to be an important method because of the development of tractor-wagon and wagon-loading equipment. Essentially the tractor-wagon method is the direct successor of mule-team and wagon haulage, which it has nearly replaced since 1928. This complete invasion of the team-haulage field in less than four years is no insignificant accomplishment, for mule-team and wagon construction of levees has held its place through the years because of substantial advantages. The new mechanization has had to increase performance by the wagon-haulage method without forfeiting any of its advantages. The means has been solely the improvement of wagon-hauling and loading equipment.

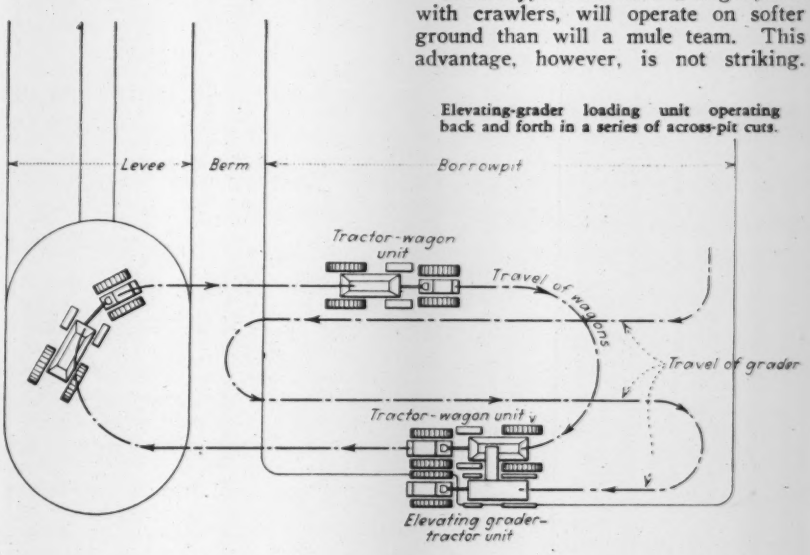
Advantages gained

Comparison is necessarily with team and wagon haulage. It is also with equipment and not with methods, which are fundamentally the same with the new equipment. The main points of comparison are the number of operating units, travel speed and ability, working time, placement of materials, compaction of fill and load capacity.

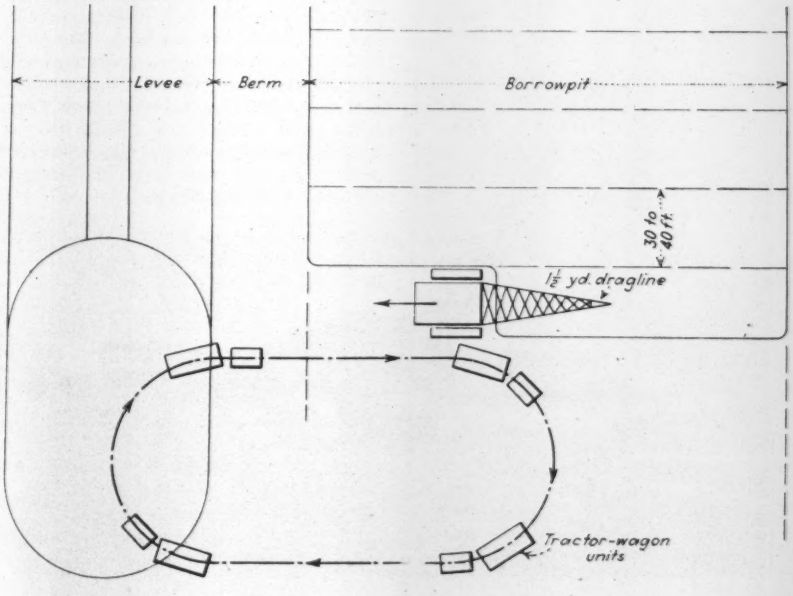
Four tractor-wagon units will replace a team outfit of 96 mules. The labor force is reduced proportionally, and camp structures and supplies and commissary and sanitary accommodations are less a task. Camps generally are smaller and have a more mechanical aspect; well-equipped blacksmith shops and oil-storage houses replace the old horseshoer, stable and hay-storage tents.

Speed of haul has been increased, and the effect of ground condition on ability to haul over it has been decreased. The three speeds of the tractor are an important factor in the reduction of the time of haul. The tractor pulls the loaded wagon at second speed, climbs the levee at low speed and returns the empty wagon to the pit at high speed. In general, a tractor-wagon unit (60-hp. tractor and 7-yd. wagon) will make a round trip in the time it takes a four-up mule unit (four mules and 1½-yd. wagon) to make the haul from pit to levee, which is about two-thirds of the round-trip time. On actual timing on a 1,000-ft. haul the tractor-wagon units made a round trip, including loading and dumping, in 9 to 10 min. Soil, weather and ground conditions were ideal.

Generally, the tractor and wagon, both with crawlers, will operate on softer ground than will a mule team. This advantage, however, is not striking.



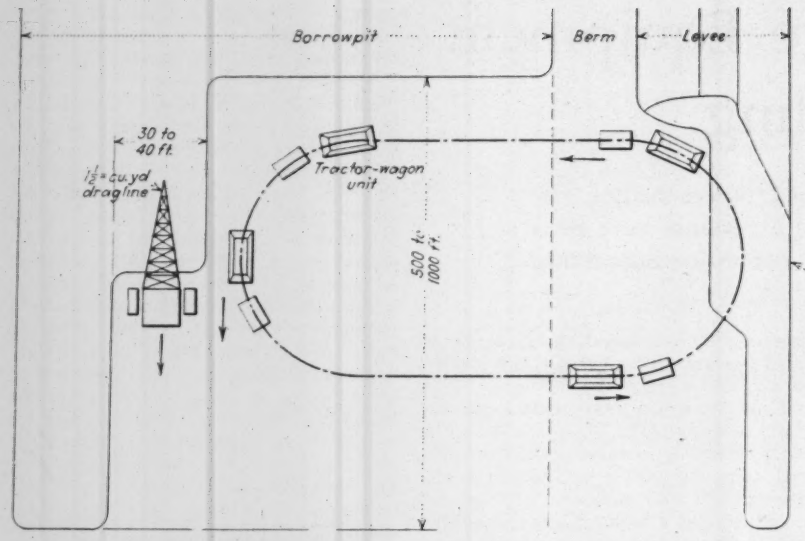
Elevating-grader loading unit operating back and forth in a series of across-pit cuts.



Loading from across-pit cuts, with both dragline and tractor wagons operating on natural surface.

Rain-soaked ground or a pit bottom close to groundwater is destruction to any haulage operation directly on the ground. The valley soils puddle under a very slight rain and give a slippery, if not a bogging, track. Just a slight shower will change the appearance of a fast-moving operation to a seemingly impossible sight in a short time. The hauling units are stalled and bogged by gummy mud, and the former well-packed runways are a sticky mass of obstruction to all travel. Haulage in wet weather is virtually impossible whether by mule teams or tractor-wagons, but, broadly speaking, the tractor-wagon will keep more material going into the levee when surface travel is difficult than will the mule-team unit.

Continuity of operation is increased by tractor-wagon units. The mechanical unit will work two or three shifts a day, whereas the mule-team unit must rest at night; day and night operation requires only that the contractor shall



Loading from cuts parallel to the pit, with both dragline and tractor wagons operating on natural surface.

organize his force for this schedule and provide lighting equipment.

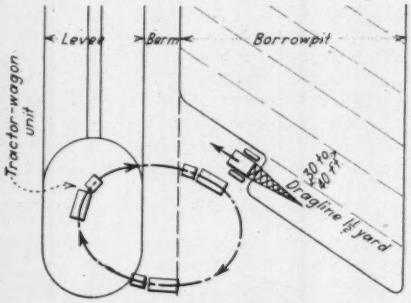
For accurate placing of material in the fill and the compaction after placing, the tractor-wagon unit has the same advantages as the mule-team unit. Accurate spotting of the dump, dumping in layers and compacting the layers by hauling over them are as sure. So effective is the performance considered to be that the levee specifications tax the method with only 15 per cent shrinkage, compared with 25 per cent for other dry-fill methods. In general, the crawler treads give compaction and texture of fill equal to those obtained by the hoofs of mules and the tires of wagons, which have always been regarded by levee builders as approaching the ideal. On the other hand, dumping difficulties with certain sticky materials, such as wet buckshot clay, are as great with tractor wagons as with the smaller mule wagons. Virtually the delta clays, when sticky, are impossible wagon-haul materials from the point of view of speed and yardage output.

The load capacity of a four-up mule-team unit is a 1½-yd. wagon load. A 60-hp. tractor will haul tandem two 7-yd. wagons when the ground is dry and firm, one 7-yd. wagon under all ordinary conditions and a 7-yd. wagon half loaded when any hauling at all is practicable.

Equipment advance

The equipment for tractor-wagon haulage is crawler tractors, crawler dump-wagons and either elevating graders or dragline excavators for loading the wagons.

Practice has standardized on crawler tractors of 60 and 75 hp., the smaller machine being most used. The power is gasoline-engine and very recently diesel-engine. The rough soft roads, with steep (10 per cent) climbs onto



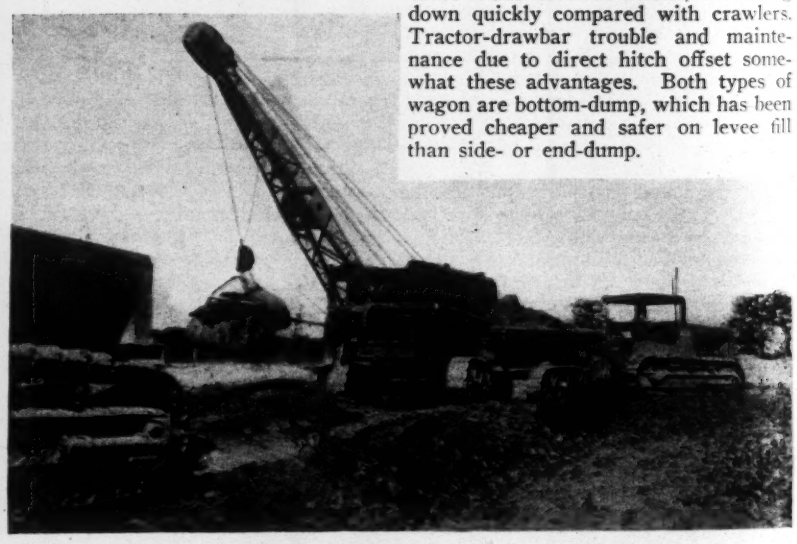
Dragline and tractor-wagons constructing levee from diagonal cuts across the pit.

the levee and often a sharp side cant in climbing and descending the levee slope, call for a low-hung broad-bearing machine with plenty of power. In general, the 60-hp. tractor has not proved any too powerful. The demands of levee work on tractor qualities other than those named are wearing resistance of crawlers and dust-proof bearings. Many of the delta soils are viciously abrasive. Tractor design and construction have been generally improved in sturdiness and wearing qualities, but the demand from the levee work is for greater improvement. Fundamentally the crawler tractor has established its efficiency as a hauling unit in levee construction.

Similarly the large-capacity dump wagon has established its efficiency, and it likewise shows need for improvement in sturdy wear-resisting design and construction. Progress, however, has been noteworthy. The original wagon of 1928 has been reinforced and made stronger in every detail, and the crawlers are being built of more wear-resisting materials. All-steel construction is now universal. Body sides and ends are steel plates with rolled edges stiffened with angles. Bottom-door construction and operation are undergoing extensive experimentation; spring-winding, hydraulic mechanism and electrically operated winders are all under test. The oldtime hand ratchet and chain still remains the preferred device, and it still meets better the changing load conditions and the requirement for fool-proof operation by cheap labor. Opportunity for improvement in door operation, however, encourages invention.

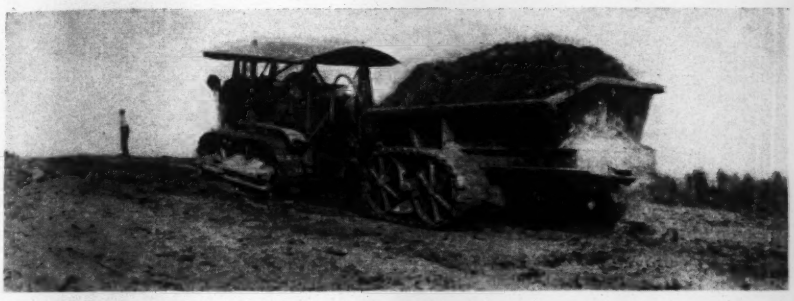
Broadly speaking, the wagons are of two types: one has wide-tired front wheels and axle to take the drawbar reactions, while the main body rides on a pair of crawlers; the other is without front wheels but has a heavy tongue connecting directly with the tractor drawbar and taking all the drawbar reactions. The preference of the contractors seems to be for the four-wheel type, perhaps because it is larger (7 cu.yd.); but the cart type (5 cu.yd.), with its direct hitch, handles better on steep slopes because of the braking action of the tractor. Also it will continue longer in operation on softening ground because it is lighter and because it has no front wheels, which bog down quickly compared with crawlers. Tractor-drawbar trouble and maintenance due to direct hitch offset somewhat these advantages. Both types of wagon are bottom-dump, which has been proved cheaper and safer on levee fill than side- or end-dump.

Dragline loading a train of two crawler wagons hauled by a 60-hp. tractor.



The most striking example of haulage-equipment advance is the elevating grader for excavation and wagon loading. Recent installations are beautifully coordinated mechanisms. The old mule-hauled machine, with the loading belt driven from the axle, has given place to a tractor-hauled all-steel machine with separate power drive for the loading belt. The belt power is on some machines from an independent motor mounted on the grader and on others from a power take-off shaft from the tractor. These new graders have rejuvenated a loading method that had been dying out on levee work.

The dragline excavators for wagon loading are more notable for operating advantages than for any special mechanical advance over standard product.



A typical tractor wagon, showing heaping of load and stiff grade to top of fill.

They are of strictly modern design with gasoline or diesel engine power and crawler traction.

Operating details

Typical arrangements of tractor-wagon operations are shown by the accompanying schematic diagrams. Without attempting a complete discussion of operating practice, a number of details are set down as of value to the equipment maker in studying the field open for improvement.

In modernizing wagon-haulage practice a step has been to operate a tractor-wagon outfit at night and a combination of motorized and mule-team outfit in the daytime. A typical example of a mixed equipment operation and one indicative of the volume of equipment is offered on a 974,000-cu.yd. job by one of the best advised contractors on the river. This operation was equipped with 34 tractors of 60 hp.; five 60-hp. and four 42-hp. elevating graders, the larger having power take-off and the smaller axle drive; 60 dump wagons (1½ yd.), each pulled by a four-up mule team; and 24 crawler wagons, seventeen 7-yd. and seven 5-yd. The operating force was 165 men.

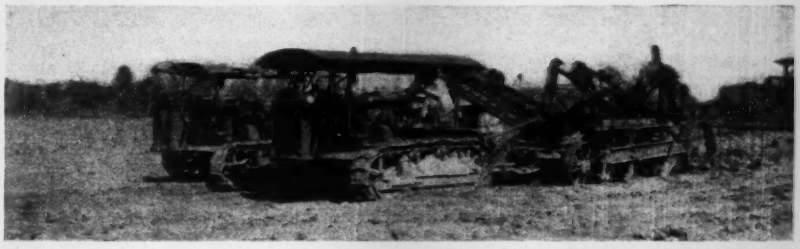
A levee-building tractor-wagon unit generally consists of two tractor-hauled elevating graders and eight 7-yd. crawler wagons, four to each grader, each hauled by a 60-hp. tractor. It is calculated that each tractor wagon carries an 8-yd. load and eliminates six 1½-yd. dump wagons, 24 mules and four men. When dragline loading is employed, a 1½-yd. dragline replaces each elevating grader. A comparison of elevating-grader and dragline loading gives the following general conclusions.

Elevating graders work at their best in long shallow borrowpits; they are used altogether in the northern delta districts where the borrowpits are limited to slopes of 1 on 50 from a starting depth of 3 ft. Stumps and ungrubbed roots make operation difficult. Moist earth is more easily handled than is dry earth, but wet ground is a serious handicap, as the machines must work on the pit bottom. Loading delays have been greatly reduced by the large crawler wagons. The grader has to wait once between crawler-wagon loads of 8 cu.yd., whereas it had six waits for 8 cu.yd. loaded into 1½-yd. dump wagons. Generally four or five crawler wagons will serve an elevating grader where the haul is under 700 ft., and nine or ten where the haul is 1,000 ft. In favorable pits an elevating grader will load twenty wagons an hour if the wagon service is prompt; average actual outputs are much smaller.

The dragline as a loading machine has the advantage that it need not operate on the pit bottom. It can excavate around stumps and roots and can, if required, do a good job in grubbing out and shifting such obstacles. Spotting the wagons for loading is not so accurate as with elevating graders, the pit bottom is not left in as good shape for wagon travel, and the material—if at all stiff—is not loaded in as good condition for easy wagon-dumping. The operating waits are fewer because the dragline can always busy itself between wagons with operations that will speed up loading. An average dragline tractor-wagon outfit will average 1,200 cu.yd. in two ten-hour shifts.

Experience indicates that wagon-haulage equipment needs to be strengthened for levee work. Tractors and wagons have to travel on extremely rough ground and steep grades. With wet fill, bogging and balling of the crawlers add pulling resistances that severely tax tractor power. Wear of crawlers is excessive. In some localities crawler parts have been virtually worn out in 30 days' continuous operation. These troubles are emphasized by lack of care in servicing and upkeep; the shift from mule-team equipment has been too rapid for complete machine-operating consciousness to have developed. Proper hostling and lubrication are neglected.

A blacksmith shop is required with every hauling outfit, with a good master mechanic and an assistant to do the oiling. Systematic lubrication is exceedingly important. An oil-storage house on skids, so that it can be shifted with the work, is required. Tractors and wagons should be brought up to the oiling house after each shift. An hour between shifts should be allowed for oiling, which should be performed by the new crew that is taking over the next shift. At the same time the machines can be examined and set out for repairs so that breakdowns may not occur on the work.



Tractor-hauled elevating grader with power take-off from tractor to operate loading conveyor belt.

Haulage equipment is put to hard service in levee construction. Generally two ten-hour shifts and often two eleven-hour shifts a day are worked. One contractor for large operations works two ten-hour shifts, and about every two weeks the day crew is shifted to night work and vice versa. Generally night shifts produce the larger yardages, probably due to less heat and fewer distractions. Portable electric-light plants and carbide lights are installed for night work.

The comparatively low first cost of a haulage outfit can be financed by small contractors. It is particularly adapted to isolated small-yardage operations for supplementing plant in large machine operations where it can borrow and place material out of economical reach of the large machines, for restoring levee slips and subsidences, for building an emergency line of levee where the whole length needs to be raised at once and where equipment needs to be quickly mobilized and massed.

Three Dams on San Andreas Fault Have Resisted Earthquakes

Parts of two earth dams that straddled the fault were moved in 1906 quake—An 8-ft. shift did not disrupt an 85-ft. fill

BECAUSE of the extent to which attention now is being focused on the safety of dams, interest attaches to the record of three dams of the San Francisco water department built before the 1906 earthquake along the San Andreas earthquake fault line. Two of these are earthfills located right on the fault and at right angles to it; the third, a large concrete dam, is located parallel to and about ¼ mile to one side of the fault. Movement on this fault in 1906 caused a shock of the maximum intensity rated on the Rossi-Forel scale. In the readjustment of the earth's crust during the quake, as shown by subsequent surveys, the entire coast line west of the fault moved bodily to the north, the permanent displacement varying up to a maximum of 12 ft. The two earth dams, although actually sheared by the movement, were not seriously damaged, and not the slightest damage was sustained by the large concrete structure near by. A review of conditions as of 1906 at the three dams and the effect of the quake upon them is given in the following.

The San Andreas fault runs along the San Mateo peninsula in a northwesterly direction, roughly paralleling the Pacific Coast shore line, and dips into the ocean about 2 miles south of the San Francisco city limits. Through San Mateo County the fault follows (and is believed to bear some relation to the origin of) a long narrow rift or valley in the upper end of which are located several reservoirs used for storing the city's water supply. A 10-mile length of this valley is occupied by reservoirs formed by the three dams already mentioned.

Movements along the fault

In the vicinity of these dams the fault traverses black and yellow adobe lands. After the quake there were many evidences of movement along the fault such as fences or rows of orchard trees that were offset 6 to 12 ft. In all these offsets it was the westerly side of the fault that had moved along the fault in a northwesterly direction. That is, all of the mountains and valleys of the peninsula to the west of the fault appear to have shifted bodily northward. The greatest movement occurred at the fault and decreased with the distance from it. Although the reservoirs were nearly full at the time, this movement did not open up even temporary outlets, and no leakage or water loss was observed.

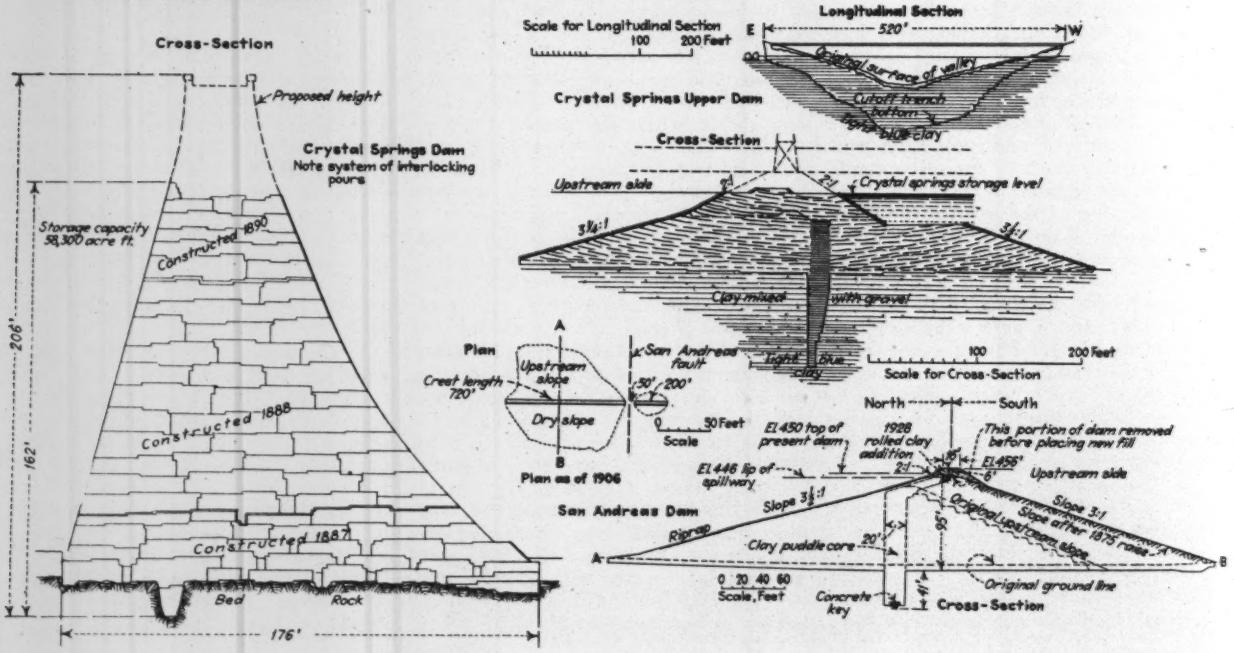
In the map plotted after the quake to show the earthquake intensity zones, an intensity of ten on the Rossi-Forel scale is indicated for an area extending about ¼ mile on either side of the fault. This puts the two earth dams in the center of the maximum intensity zone and the large Crystal Springs concrete dam on its outer edge.

The methods of construction employed in the two earth dams were the same and consisted of cutting a core trench down to tight bedrock, filling this and carrying the core on up as the fill progressed, with puddled clay, which was placed in thin layers, thoroughly spaded and tightly rammed. Material in the remainder of the dam was laid in 10-in. layers inclining downward toward the center on a slope of about 1 in 40, each layer being lightly watered and compacted with a 3-ton roller.

Fault passes through a ridge

San Andreas Dam—The San Andreas dam, at that time 95 ft. high above streambed and 130 ft. above cutoff trench bottom, had the major portion of its bulk, which lies to the west of the fault, moved 8 ft. along the fault. This dam then consisted of two parts separated by a narrow ridge through which the fault passes about 200 ft. from the extreme northeast end, approximately at right angles to the dam center line. This comparatively hard ridge containing the fault was not taken out when the foundation was stripped, and thus the dam with the height it had in 1906

Section of the Crystal Springs dam, of the Upper Crystal Springs dam and a section and plan of the San Andreas dam, showing its relation to the fault line.



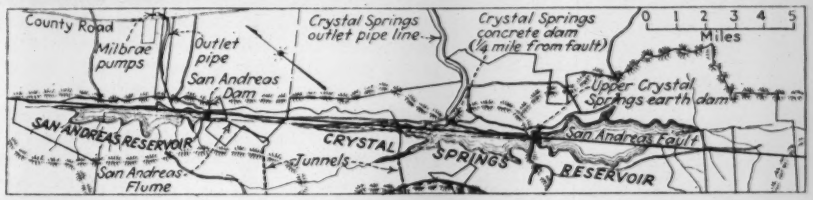
The 8-ft. offset in the fence shows where the fault line passes through Upper Crystal Springs dam. Road and fence were straight before the quake. West of the fault the dam moved. East of the fault it remained.

was divided into two parts by this upthrusting formation in which the fault occurs. As later raised, the crest is above the level of the fault surface, and hence the structure is no longer divided at this point.

With reference to earth movement on the fault, as observed at this dam, Charles Derleth, Jr., department of civil engineering, University of California, said: "There was an oscillating shearing action of the surface materials, so that the material to the east of the fault line rubbed against that at the west. This shearing oscillation was not wholly horizontal but must have had some vertical component. . . . Of course, these surface movements must be due to a rupture in the hard materials beneath, but just what has occurred in the firm crust below is not entirely evident." (*Engineering News*, May 17, 1906, p. 548.)

An outlet tunnel around the eastern end of the dam was ruptured in the plane of the fault, and that part of the tunnel west of the fault moved northward about 8 ft. The intake tower, which stood on the fault, pipe lines that crossed the fault, and other structures on or near it were demolished or seriously damaged by the shocks.

The dam itself was somewhat cracked by the quake, notably in the form of small longitudinal cracks thought to be due to the unequal settling of the triangular masses with respect to the core. There were larger cracks running northwest on the bank above the eastern end of the dam and a few small cracks running in the same direction at its western end. The only reconstruction necessary, however, was the resurfacing over the fault itself. No leakage occurred, and the dam has continued in service to date.



Relation of the three dams of the San Francisco water department to the San Andreas fault.

Original construction of this dam was completed in 1870; it was raised first in 1875 and again in 1928. The second raising brought the crest to its present height of 101 ft., or 6 ft. above the 1906 height. The 1928 work on the dam also included construction of a new and larger spillway consisting of a concrete-lined weir or wasteway 100 ft. wide at the crest of the dam. This spillway is built over the San Andreas fault, but inasmuch as the wasteway is purely a precautionary measure and will function only very rarely, if ever, the risk of earthquake damage during overflow is considered negligible.

Upper Crystal Springs Dam—Upper Crystal Springs dam is 85 ft. high above streambed, and its crest is 190 ft. above cutoff trench bottom. It was completed in 1877, but at the time of the earthquake it was not withstanding hydrostatic pressure because an open conduit through the structure made its reservoir a part of the larger Crystal Springs storage, and water was thus standing against both sides. The fault line passes under this dam about 80 ft. from its northeast end approximately at right angles to the dam center line. After the quake all that part of the dam on the west side of the fault was found to have moved about 8 ft. to the northwest.

As was the case at the San Andreas dam, the brick-lined conduit around the Upper Crystal Springs dam was shattered for a length of 20 ft. where it crossed the fault, and that part of it on the western side of the fault plane moved northwesterly 5½ ft. After the quake the portion of the conduit west of the fracture was found to be 1 ft. lower than that part of the conduit to the east. The dam itself, however, suffered no apparent damage, and no reconstruction was necessitated by the quake.

Concrete dam unaffected

Crystal Springs Dam—The Crystal Springs dam, begun in 1887 and practically finished to its present height in 1890, is 145 ft. high above streambed and 162 ft. from lowest concrete to parapet crest. Its center line is curved on a radius of 637 ft. This was the first concrete dam built in the West. It was designed along most conservative lines, with successive concrete pours placed in interlocking blocks forming an intricate pattern, this costly precaution being taken to prevent any weakness that might develop from cracks continuing through the structure. Construction was prolonged over a three-year period to allow the early pours to become well set before subjecting them to full load.

The ratio of the 176-ft. base width to the 206-ft. height for which the dam was designed would have been 0.85 to 1. The dam never has been carried up to this height, however, so that the ratio of base width to the present height of 162 ft. is 1.08 to 1.

The axis of this structure is roughly parallel to the fault, which is about ¼ mile west of the dam. Careful examination after the quake did not disclose the slightest damage of any sort, although, in Professor Derleth's opinion, "It was subject to a series of thrusts and pulls in vertical planes along its length." Professor Derleth also said: "So far as the writer could see, and he observed the dam carefully, there is not the slightest crack."

Construction pictures, together with a report of a recent inspection of this structure, by F. R. McMillan and M. B. Lagaard, were published in *Engineering News-Record*, May 8, 1930, p. 766.

Sliding and Swinging Windows for Commercial Buildings

Double-hung sliding type most extensively used —Pivoted and folding types in great variety and number—Wood and metal—Window cleaning

LARGE window openings and window areas in proportion to wall areas are characteristics of modern building design that have led to numerous developments in window construction, particularly in a variety of designs of pivoted and swinging sash as alternatives for the ordinary double-hung vertically sliding sash. The present article deals more with public and semi-public buildings, including schools, libraries and hospitals; and with such commercial buildings as offices, hotels and large apartment structures. Window construction for industrial buildings, such as mills, factories, power plants and warehouses, has been developed more extensively and on more uniform lines than in the other types of buildings, but it is included incidentally.

That the double-hung sliding-sash type of window continues to be used to a much larger extent than any of the substitute types is an interesting and significant fact attested to by architects in general, indicating the practical value of this type and the possibility of its development to meet modern conditions and requirements. In fact, a canvass of a large number of leading architects specializing in public, semi-public and commercial structures shows practical unanimity of opinion that the double-hung sliding-sash type is the most widely used and the best all-round type of window today. One of the largest architectural firms states that this type of window is provided in 99 per cent of the buildings designed by them.

Other types of windows have advantages of their own, of course, but have by no means superseded the older type. Such other types are used largely under special conditions, such as: (1) greater suitability to certain architectural designs or to certain interior arrangements or occupancy; (2) requirement for large ventilating area, particularly in schools and hospitals, since the ordinary sliding-sash type limits this area to about 50 per cent of the area of window opening; (3) where very large units are desirable, as for public offices and libraries, studios and upper-story showrooms. As to this last condition, however, it appears that double-hung sliding-sash windows are often provided in very large units. Selection of type of window by architects, therefore, is based mainly upon such considerations as architectural design, occupancy, light and ventilation requirements, cost, maintenance expense, ease and reliability of operation, fireproof and weatherproof qualities, and convenience of arranging screens, shades and hangings.

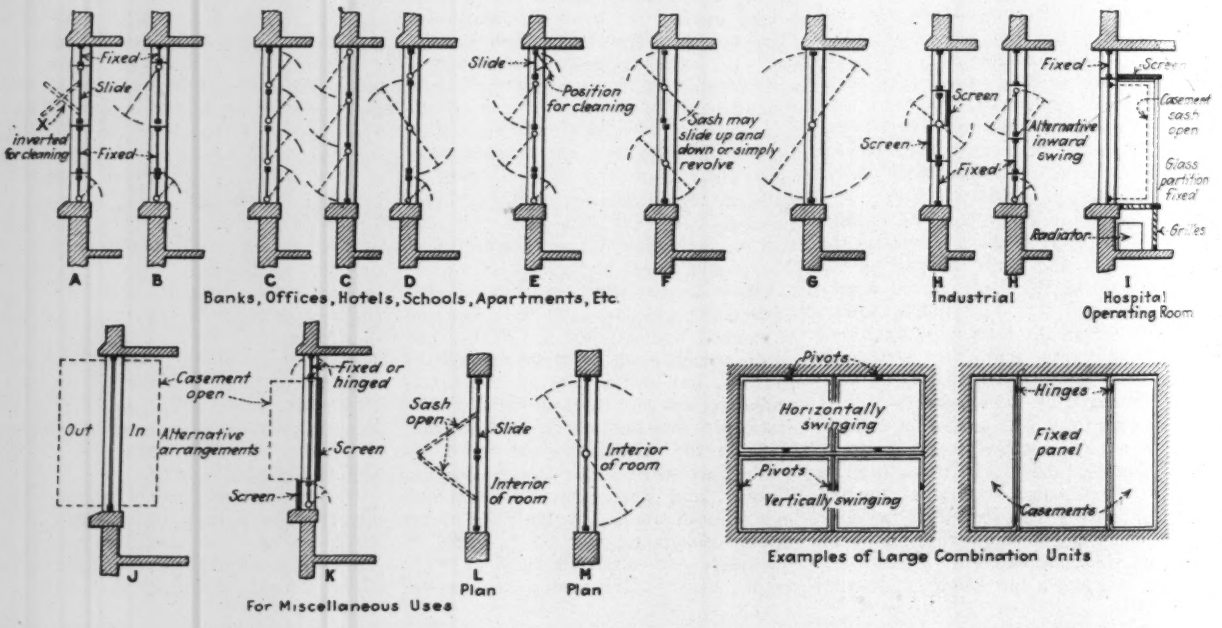
In view of the extensive use and universally favorable opinion of the double-hung window, some manufacturers have modified it to overcome certain disadvantages inherent in this type, such as the restricted open area for ventilation and the difficulty or possible danger of outside cleaning. For this reason they provide special attachments, which can be applied also to existing windows, enabling the sash to pivot at mid-height and thus be reversible for cleaning, besides giving practically 100 per cent window opening. New windows of this modified design may be simply pivoted in their frames and have no sliding movement. In either case, when the sash are swung to the horizontal position they form a negligible obstruction to the passage of air.

Types of swinging windows

Several typical arrangements of windows with swinging and folding sash are shown in the accompanying drawing, but modifications and combinations of these are used in endless variety. Two examples of combinations are shown on the drawing. In one of these the upper half of the window has two sashes swinging on vertical pivots at the center line, while the lower half has two sashes swinging on horizontal pivots at about mid-height. In the other case a large fixed-center panel for second-story showroom display has at each side a hinged casement panel for ventilation.

Of the series of windows shown on

Special window types present variety of styles and combinations.



the drawing, types *A* to *F*, inclusive, and type *L*, are used in buildings of numerous classes such as schools, hotels, banks, offices, libraries and apartment buildings. Type *G*, pivoted at mid-height or at top, and type *M*, pivoted vertically at mid-width, are used only exceptionally. Type *H* shows two common arrangements for windows of mills, factories and industrial buildings in general. Casement windows, as at *I*, *J* and *K*, are used largely for residences, apartments and studios but also for schools and hospitals and to some extent for upper-story stores or showrooms. Brief explanations of the arrangements shown are as follows:

A — The larger ventilating sash slides down and outward in opening; to clean the outside from within the room, the sash can be reversed to position *X*. The smaller movable sash or deflector swings inward.

B — The larger sash swings outward from the top, while the smaller one swings inward and serves as a deflector.

C — Three or four sections of horizontal sash swinging inward or outward may be operated in series or independently. Modifications of these arrangements include various alternations of fixed and movable sash.

D — With the larger sash pivoted at mid-height, it swings partly inward and partly outward; both the smaller sashes swing inward.

E — Two large sashes swing out and two small ones swing in, the top inward sash dropping far enough to allow of cleaning the outside face of the glass from inside the room. The sash may swing on fixed pivot points, as shown, or may move in side guides like the larger sash at *A* in the drawing.

F — Double-hung vertically sliding sash have pivots to permit of reversing them, so that both sides can be cleaned from the inside. The upper sash is lowered before it can be reversed. Existing windows can be fitted with the necessary attachments. In an alternative and cheaper arrangement the sash do not slide but merely swing on fixed pivots or trunnions.

G — This entire sash, usually of large size, is pivoted at mid-height, or sometimes at the top.

H — Two common arrangements for steel-sash windows of industrial buildings are shown, with a method of screening.

I — A special draft-preventing and air-conditioning arrangement of inclosed casement windows for a hospital operating room.

J — A simple casement window, usually with two hinged panels. The sash may open inward or outward, but large casements opening outward may be difficult to handle in windy weather.

K — This combination of casement sash and horizontal swinging sash is said to have advantages in good ventilation without drafts.

L — In this design there are no hinges or pivots, but the vertical meeting rails of the sash move outward in a straight line, the opposite side of the sash sliding in horizontal guides at top and bottom. Lever attachments regulate the movement.

M — The entire large sash is pivoted on its vertical center line.

Pivoted windows, among the first departures from the vertically sliding type, were swung on horizontal trunnions just above mid-height. But the combined inward and outward movement had some disadvantages, especially in making it difficult to screen, shade and drape the opening. These objections were largely eliminated by the development of the so-called projected window, with the sash sliding in vertical guides at the ends instead of having fixed pivots. Thus there is no projection inside the wall to interfere with screens or hangings. The open sash sheds rain and can be reversed for cleaning the outside face from within the room. Where the top sash of projected type moves inward, as at *D*, it slides upward instead of downward in the guides.

This projected type of sliding sash seems to be used more extensively than the simple pivoted sash, except in windows of the casement type. However, the construction shown at *L* in the drawing consists of sliding casement sash. Furthermore, some casements have a slight sliding motion away from the jambs in order to leave side openings of sufficient width for washing the outside of the glass from the interior of the room. In some pivoted casements also the pivots are carried by brackets in the sash and window frame, so that in opening the window the sash swings entirely clear of the frame. For such arrangements stout and substantial construction is necessary to provide against warping and distortion and to insure easy operation and tight closing without frequent adjustment or maintenance expense. Self-cleaning hinges are necessary for the same purposes.

Most of the architects consulted note a general objection to swinging windows in the difficulty of screening the opening and conveniently arranging shades and drapery. These difficulties, however, can be and have been overcome in different ways. Windows with out-swinging sash may have screens on the inside, the sash being operated, controlled and latched by simple lever devices extending inside of the screen. In-swinging sash may have outside screens so arranged as to be placed or removable from inside the room.

It appears to be a general opinion also that such swinging windows are less weathertight and watertight than the ordinary sliding sash. Manufacturers do not agree with this opinion, naturally, and in fact many designs of swinging sash provide for weather-stripping with felt or bronze on contact faces. On the other hand, architects call attention to the advantages of different types of swinging windows in better light and ventilation and better facilities for cleaning the outside of the sash. Almost invariably also, attention is called to the fact that certain conditions of architectural design and interior treatment require the use of special types of windows.

Cost of the different types of windows is rarely a factor of importance in the selection for an individual building, so that comparisons of costs are difficult owing to varying conditions. Several architects refer to the relative low cost and maintenance expense of double-hung sliding sash, while a few find swinging types lower in cost but do not make reference to maintenance.

Schools, hospitals and many institutional buildings require specially large window areas for ventilation and light but also require careful attention to the diffusion of air and the prevention of drafts. For such conditions various forms of swinging sash are especially adapted, and the arrangements shown at *A*, *B* and *E* in the drawing have been suggested particularly as meeting these requirements. The same conditions apply with greater force to operating rooms in hospitals, one arrangement for which is shown at *L*. Here tall casement windows have sash swinging inward but shut off from the body of the room by a fixed glass partition. The compartment thus formed is closed at the bottom by a grille over a radiator, and over the top is a screen. Thus the entering air is warmed (or cooled) in the semi-closed compartment before passing through the screen into the top of the room. An advantage claimed for some designs of swinging windows is that for hospitals, charitable institutions and prison buildings the range of opening can be limited to prevent accident, suicide or escape, without requiring the use of bars or gratings. But more than one architect states that the managements of institutions often prefer the double-hung sliding sash on the score of greater security, less cost and less trouble with maintenance, screens and shades.

As to metal and wood construction of window frames and sash, a quite general opinion is that the main advantage of metal is in permitting the use of very large window units with ample strength. That there is greater air leakage with metal construction also seems to be a general opinion. In a more favorable attitude it is indicated that metal sash and frames are desirable for public and semi-public buildings, as they will not warp, swell or shrink in service and will require less cost for maintenance than wood constructuon.

The question of fire resistance enters, but it has been pointed out that while metal sash may not burn, it may so warp and twist under heat as to shatter the glass. Fire tests indicate, however,

a high degree of fire resistance with wire glass in metal sash.

Rolled- and pressed-steel shapes are used in great variety by different manufacturers, with extensive applications of bronze for sliding shoes, bushings and other movable parts, to eliminate rust or corrosion, reduce wear and provide permanent ease of operation. Aluminum is coming into more extensive use. Bronze weatherstripping is also used in some cases, to prevent rattling as well as to make the joints watertight. In recent years great advances have been made in window hardware, providing greater reliability, strength, ease of operation and effective appearance. In fact, modern metal window construction seems able to meet satisfactorily all requirements.

Window Cleaning—Cost of window cleaning and the liability of injury to those engaged in washing the outside of ordinary sliding-sash windows, especially in tall buildings, are important considerations in many cases. Most types of swinging windows have a larger safety factor in this respect, and the possibility of equipping ordinary windows with devices enabling the sash to be reversed has been mentioned already.

It is stated that in the careful comparison (some years ago) of a hotel having sliding sash and its annex having reversible sash, it was found that the cost of washing the latter was about 33 per cent less than the former, due specially to the quicker work. This difference may apply where the washing is done by employees. But inquiry of window-cleaning firms and associations of building managers does not indicate that the type of window is a factor in the charges for cleaning. Uniform charges, however, may be due largely to the fact that comparatively few buildings of the class handled by such window-cleaning firms are equipped with any but the ordinary type of double-hung sliding sash.

Water Commission Advises Against Sprinkling Ban in Minneapolis

Engineers report that the reduction in daily demand does not warrant the inconveniences caused by restrictions

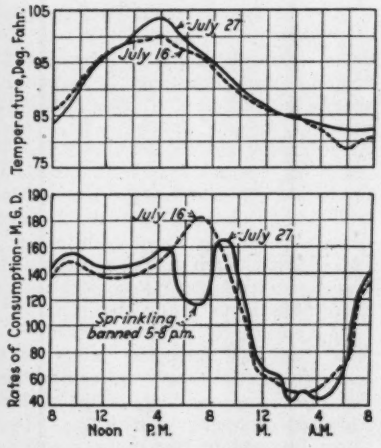
THE RATE of consumption of water for sprinkling rises rapidly with the temperature, and in many cities (particularly in the residential districts) the maximum figure it attains determines the capacity of the various units of the waterworks system. In the North Shore suburbs of Chicago the consumption on occasion rises to 700 gal. per capita daily. In Minneapolis (465,000 population in 1930) the 1931 summer consumption, although the city is metered, rose to unprecedented figures. Never before had 100 m.g.d. been pumped, but last year the pumpage exceeded 100 m.g.d. on 21 days, it exceeded 110 m.g.d. on ten days, and on four days it exceeded 120 m.g.d. and reached 125 m.g.d. During July, 1931, when these high rates occurred, there were fifteen successive days in which the average of maximum temperatures was higher than that of any five consecutive days in any year since 1902. The filtration plant and pumping stations were capable of meeting the demand, but the distribution system proved to be inadequate in certain parts of the city.

This inadequacy of the distribution system precipitated the formation of a water commission to investigate and report on all phases of the water problem. As indicated in *Engineering News-Record*, June 16, p. 871, that commission has since reported. The city council has recently approved the request of the waterworks committee for $850,000 bonds with which to build two coagulation basins and a reservoir and pumping station in South Minneapolis. These improvements will relieve the condition made serious by the irrigation or sprinkling load.

Increased capacity rather than restrictions on water use were stressed by the water commission. It noted that the result of the sprinkling restriction on July 27, 1931, was to increase the use of water during, before and after the prescribed hours and to reduce the peak demand for the day by about only 16 m.g.d. Considering the inconvenience caused by prohibiting sprinkling from 5 to 8 p.m., when most people have the time and the inclination to be outdoors, the reduction of less than 10 per cent in peak demand was of small consequence from the viewpoint of reducing the load on the distribution system. The total water consumption on July 27, as determined from the hourly rates, was only 2½ per cent less than on July 16, when there were no restrictions. The figures for the daily amount of filtered water furnished by the water department for those days show a difference of 7 per cent.

Tests on a number of sprinkling nozzles, lavatory and kitchen faucets indicate that if every home in the city engaged in sprinkling between 5 and 8 p.m. and also used intermittently one faucet in the kitchen or bathroom during the same hours, the aggregate water demand during those hours would be about double the maximum thus far recorded. Rather extensive observations made by the commission during the hot days of early September, when the demand rose to 156 m.g.d. at 7 p.m. (Sept. 10), indicate that probably not more than one-fifth of the residents of South Minneapolis were sprinkling at the same time. There already exists a tremendous diversity of sprinkling demand that cannot be substantially increased by sprinkling restrictions. For example, assuming that on a given day of high demand half the people are sprinkling at any given hour of the evening, and that an attempt is made to restrict sprinkling to even-numbered houses on one day and to odd-numbered houses on the next, obviously half of the people would still be sprinkling at the same time, and there would be no appreciable reduction in the sprinkling peak.

In the opinion of the commission, all sprinkling restrictions are undesirable. People chafe under such restrictions. Unless the total amount of water that the householder is permitted to use for sprinkling purposes is limited to such an extent that lawns and gardens will be practically ruined, sprinkling restrictions are relatively ineffective in reducing the required capacity of the waterworks.



Sprinkling restrictions eliminate peak demand but negligibly reduce total consumption per day.

Hand Labor Repairs Oldest Concrete Road in Country

The 39-year-old concrete pavement around the court house at Bellefontaine, Ohio, is being repaired as an unemployment relief measure, all work being done by hand. This pavement is considered to be the first concrete pavement laid in the United States.

A Discussion of the Unit-Graph Method of Estimating Runoff

Hydrologists and hydraulic engineers present their views on the soundness and workability of the proposed method of computing a hydrograph from rainfall data

THE UNIT-GRAPH method of estimating streamflow from rainfall data was first described by L. K. Sherman in an article in *Engineering News-Record*, April 7, 1932, p. 501. The object of the computations outlined in that article is to enable the engineer to construct, with reasonable accuracy, the hydrograph corresponding to any sequence of daily precipitation records. The method involves, first, the construction from observed data of a "unit graph," representing the runoff from a given area caused by a rain producing a runoff depth of 1 in. in 24 hours, or in a unit of time. The daily ordinates of the unit graph are then multiplied successively by the rainfall intensities for each day of the storm under consideration, and the resulting daily partial runoffs are added to give the ordinates of the corresponding hydrograph.

—EDITOR.

New Flood Formulas Based on Same Principle as Unit Graph

By H. K. Barrows
Consulting Engineer, Boston, Mass.

THE IMPORTANT principle in this method of analysis is that the base of the hydrograph for any given stream and storm period in days is of constant length, the hydrograph having a triangular shape with a constant base but an altitude varying with the amount of rainfall (or runoff) in the given time period.

This principle is fully described in the report of the committee on floods of the Boston Society of Civil Engineers (*Journal*, B.S.C.E. for September, 1930) in chapter V of that report and is the basis for the flood formulas suggested by the committee. A brief résumé of these is as follows:

Where a flood hydrograph or hydrographs are available:

$$q = \frac{1290\,R}{T} \qquad (11)$$

q = peak flow, in second-feet per square mile.
R = flood runoff, in inches depth on the drainage area.
T = the "total flood period," in hours (or the base of the hydrograph).

As a general formula for New England: in formula (11) putting $T = C_t\sqrt{A}$

$$q = \frac{1290\,R}{C_t\sqrt{A}} \quad \text{or} \quad q = C_r\,\frac{R}{\sqrt{A}} \qquad (14)$$

and $$Q = C_r\,R\,\sqrt{A} \qquad (15)$$

where C_r is a coefficient reflecting the flood- or runoff-producing characteristics of a drainge area.

The committee also suggested the use of "flood-characteristic curves" for comparing different streams, obtained as follows:

Dividing time and discharge in a flood hydrograph by A, a new hydrograph will be obtained for a similar flood on a similar area of 1 square mile. Again, dividing the new values of discharge by the number of inches of flood runoff, a hydrograph of a 1-in. flood on 1 square mile will be obtained—called the "characteristic-flood curve."

This method enables direct comparison of streams as regards flood-runoff characteristics. It is also evident that the peak point of the flood-characteristic curve gives the coefficient C_r in formula (11).

Mr. Sherman is to be commended for his interesting and careful analysis of this method, which will be very useful in rainfall runoff studies.

* * *

The Unit Graph Is Not Constant

By Charles H. Pierce
Senior Hydraulic Engineer, U.S.G.S.

A REASONABLE explanation for the development of this method is given by Mr. Sherman in the final paragraph of his article where he says: "The unit-graph method enables a runoff record to be computed when only limited streamflow data are available." The only serious objection to that statement is that Mr. Sherman's method does not furnish a runoff record. The unit-graph method is an ingenious way of estimating runoff by means of rainfall data and a comparison with an actual streamflow hydrograph.

By the use of the unit graph Mr. Sherman endeavors to introduce the individual characteristics of the drainage basin as they affect the runoff hydrograph. This is logical and is a long step forward from the numerous attempts to estimate runoff as a flat percentage of rainfall, or even as the estimated residual amount after deducting losses. Unfortunately for the accuracy of the method, the size and shape of the runoff hydrograph following a definite amount of rainfall, say 1 in. in 24 hours, is seldom or never the same for the same drainage basin but will vary with the time of year, the conditions of the soil, the conditions of plant growth, groundwater and various other factors. A rainfall that would produce a rapid runoff and consequently a considerable rise in stage of a river under some conditions might, under other conditions, affect the discharge very little. Mr. Sherman's computed hydrograph for the Big Muddy River at Plumfield, Ill., for April and May, 1927, was arrived at by the use of a unit graph that was derived from data for April 9, 1924. Conditions for those two periods might have been similar, yet it may be seen that the computed hydrograph is widely different in magnitude, although similar in shape, to the hydrograph of observed discharge as published by the U. S. Geological Survey. To enable one better to appreciate the numerical differences between the two graphs, a comparison of the actual figures is given in Table I on p. 224.

From this table it will be seen that the daily discharge as estimated by the unit-graph method for the period April 11 to May 31, 1927, varies from 11 to 400 per cent of the measured discharge. With this range of uncertainty during a six-weeks period, it would hardly seem that much reliance can be placed upon such figures for use in investigations of drainage, flood control, water power or water supply.

It would be helpful if Mr. Sherman would show a comparison between the figures arrived at by his unit-graph method and the figures based on streamflow measurements of the same river at another time of year when the conditions of the soil, plant growth, and groundwater were different from the conditions existing at the time he derived his unit graph.

The rainfall for the month of September, 1930, as recorded for Benton and Mt. Vernon and weighted as indicated by Mr. Sherman, gives practically the same average precipitation as the weighted average for the month of May, 1927. Yet the measured runoff for May, 1927, was more than seven times what it was for September, 1930.

May, 1927			
Benton precipitation 7.55 in. with weight	0.57	=	4.30 in.
Mt. Vernon precipitation 8.21 in. with weight	0.43	=	3.53 in.
Weighted average for 753 sq.mi.		=	7.83 in.
Measured runoff from 753 sq.mi.		=	3.23 in.
Computed runoff by Mr. Sherman		=	3.88 in
September, 1930			
Benton precipitation 6.30 in. with weight	0.57	=	3.59 in
Mt. Vernon precipitation 9.95 in. with weight	0.43	=	4.28
Weighted average for 753 sq.mi.		=	7.87 in.
Measured runoff from 753 sq.mi.		=	0.45 in.
Computed runoff by unit-graph method		=	?

Very likely the unit-graph method, or a modification of it, may prove helpful in many cases where actual streamflow records are fragmentary. However, it should be recognized that the method can be expected to give results only approximately correct and that it is based upon fundamental assumptions that are not strictly accurate. Some of these assumptions, called "laws" by Mr. Sherman, are as follows:

1. "Following a storm, the hydrograph representing the flow in the main stream channel shows the runoff increasing to a maximum point and then subsiding to the value it had before the storm."

Actually, if there had been a period of dry weather immediately preceding the storm, it might be many days, even weeks, before the runoff subsided "to the value it had before the storm."

2. "For the same drainage area . . . there is a definite total flood period corresponding to a given rainfall, and all one-day rainfalls, regardless of intensity, will give the same length of base of the hydrograph."

The fallacy of the above statement should be obvious to any one who has observed rainfall and streamflow and watched the effects of storms of different intensities at different times of year. The effects of different conditions of soil, groundwater and plant growth have already been commented on.

3. "If a given one-day rainfall produces a 1-in. depth of runoff over the given drainage area, the hydrograph showing the rates at which the runoff occurred can be considered a unit graph for that watershed."

This statement should be modified to explain that the unit graph thus derived can be considered applicable only for conditions similar to those existing at the time the hydrograph was obtained.

4. "After a unit graph has been constructed for a particular area it may be used to compute a hydrograph of runoff for this area for any individual storm or sequence of storms of any duration or intensity over any period of time."

If the above statement were true, the work of the engineer seeking dependable records for use in any project requiring a knowledge of streamflow would be much simplified. It may be unnecessary to point out that two rain gages on an area of 753 square miles cannot be expected to give a true measure of the average precipitation over the entire area, or that the difference between the indicated and the true average precipitation may vary widely at different times. The important thing is that the same amount of precipitation that gives 3.23 in. runoff in May possibly will give only 0.45 in. runoff in September and less in August, depending upon conditions.

Therefore, it is believed that the limitations of this unit-graph method should be brought to the attention of engineers and others who may not have had opportunity to observe the very large effects that soil conditions, groundwater, plant growth and various forms of evaporation losses have upon surface-water runoff.

* * *

Divergent Data Need Study to Perfect the New Method

By C. S. Jarvis
Principal Hydraulic Engineer, U. S. Engineer Office, New York, N. Y.

THE OPENING paragraph of Mr. Sherman's paper is startling in the breadth of its assertion that, by the application of methods therein illustrated and outlined, it is possible to compute for a given watershed the runoff history corresponding to a rainfall of any duration or degree of intensity. Nevertheless, a careful unbiased analysis of the subject matter and typical examples as presented, and particularly the graphs of forecast and observed runoff in streams of widely divergent characteristics, will go far toward establishing the claims beyond reasonable challenge for the watersheds and gaging stations cited and for the particular phenomena observed and reported.

Appreciating the earnest constructive efforts of the author in developing such a simple, rational and workable method, the writer desires that the following comments be construed as an outline of work yet to be accomplished before the unit-graph method can be accepted as of general application, and not as opposition to the author's views. The paper marks a distinct advancement in the scientific approach to an elusive and complicated problem.

As might be expected, the author has admitted in connection with percentage of runoff that, "Each curve is applicable to a certain month only." Then the question normally arises as to the applicability of the method for forecasting January runoff when typical May weather prevails. Within the writer's experience and observation there are streams, watersheds and gaging stations that would show very marked inconsistencies of behavior if analyzed by the author's method, it appears from a preliminary study. Within the same season there were marked variations in period of flood, intensity and percentage of runoff that could hardly be forecast but that became matters of record. One such example is described in *Transactions*, Am. Soc. C.E., 1926, vol. 89, p. 988, "Foodflow Characteristics," under the subtitle, "Diverse Floodflows." Before the unit-graph method can be established as of general application the divergent data should be thoroughly sifted, compared and either reconciled or accounted for by as rigorous methods as are required for the original development.

TABLE I—COMPARISON OF RUNOFF COMPUTATIONS FOR BIG MUDDY RIVER AT PLUMFIELD, ILL., APRIL AND MAY, 1927

Day	April			May		
	Discharge From U.S.G.S. Records	Discharge by Unit-Graph Method	Ratio Computed to Recorded	Discharge From U.S.G.S. Records	Discharge by Unit-Graph Method	Ratio Computed to Recorded
1	.....	.....	....	1,900	2,954	1.55
2	.....	.....	....	2,650	3,500	1.32
3	.....	.....	....	2,750	3,432	1.25
4	.....	.....	....	2,360	2,686	1.14
5	.....	.....	....	1,720	1,833	1.06
6	.....	.....	....	1,200	1,506	1.25
7	.....	.....	....	1,160	1,594	1.37
8	.....	.....	....	1,400	2,578	1.84
9	.....	.....	....	1,960	3,594	1.83
10	.....	.....	....	2,520	5,119	2.03
11	2,780	2,116	0.76	4,730	5,599	1.18
12	3,450	4,201	1.22	5,500	5,646	1.03
13	4,690	6,188	1.32	5,140	5,014	.98
14	7,300	8,580	1.18	4,330	3,840	.89
15	9,500	10,229	1.08	3,430	2,464	.72
16	10,800	11,481	1.06	2,480	1,415	.57
17	10,900	10,924	1.00	1,700	837	.49
18	10,500	9,375	.89	1,120	562	.50
91	9,700	7,355	.76	545	548	1.01
20	8,900	5,196	.58	359	465	1.30
21	7,800	3,500	.45	309	448	1.45
22	6,700	2,377	.35	252	944	3.75
23	5,490	1,640	.30	263	1,045	4.00
24	4,370	1,169	.28	530	1,796	3.40
25	3,270	750	.23	1,260	2,524	2.00
26	2,260	448	.20	1,500	2,809	1.87
27	1,580	230	.15	2,070	2,906	1.40
28	1,030	114	.11	2,200	3,275	1.49
29	790	1,333	1.69	2,700	2,965	1.10
30	1,560	2,276	1.46	2,750	2,502	.91
31	.....	.....	....	2,520	2,120	.84

* * *

For Peak Flows or Total Runoff, Use Usual Methods

By C. E. Grunsky
Consulting Engineer, San Francisco, Calif.

IN SOME PARTS of the country, where surface conditions of the watershed are fairly comparable at all times of the year, this described method of building up a probable discharge curve may have some value. Where the runoff is from dry porous ground or from frozen ground or where rain falls on snow there may be so many indefinite factors introduced that the method may fail in yielding dependable results. Perhaps the author has in mind a unit graph for each calendar month.

Bearing in mind the fact that the study of past records of rainfall and of

streamflow is for the purpose of laying a foundation for the prediction of future probabilities or possibilities, there still seems to be much in favor of the usual method of procedure when the maximum discharge of a stream or the total runoff in a certain time period is to be forecast from an assumed sequence of minutes, hours or days of rainfall.

In the case of large watersheds when maximum streamflow is to be forecast some known or closely approximated peak discharge in its relation to the heavy rainfall that has caused it is brought under study. The information secured is then used as a starting point. The extreme rainfall conditions that should produce a maximum runoff rate are then assumed or, more precisely, they are determined from the best available data, and by comparison, aided by stormwater formulas, the probable maximum stream discharge is estimated. Under this method the near extreme condition is used instead of Mr. Sherman's unit graph. The necessity of

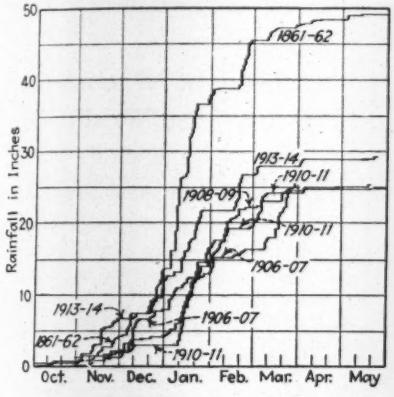


Fig. 1—Mass curves of rainfall, such as this one for San Francisco, have been found helpful in studying floodflows.

building up from small units is thus avoided.

It is, of course, doubtful whether anything better than the determination of a probability can ever be hoped for in cases where from 1 to 10 in. of rain may be needed to wet up the ground and prepare it for the ideal condition in which 1 in. of rain will have the same effect on runoff as any other inch.

While on this subject, attention might be called to the mass curves of rainfall shown in Fig. 1, which have been found very helpful in studying floodflows. (See report of the commissioner of public works, California, 1895.) Still more useful are similar diagrams showing the mass curve of heavy rains plotted in percentage of the normal annual rain instead of in inches. Such mass curves are suggestive of what may happen at some time in the future. It is here that the engineer's personal judgment must control. He selects the type and duration of the rainstorm that is most likely to produce the extreme high water. Nature will not do this for him. Nevertheless, what nature has already given us in the course of the years that are now covered by observations becomes our aid in forming opinions as to future probabilities. Moreover, it is just as important to be fairly near the truth in the interpretation of rainfall records as it is to deduce probable discharge from such records when they are used as the starting point. It follows that extreme refinement in translating rainfall into runoff or into maximum runoff rates is rarely warranted.

* * *

Studies Show Unit Graph Is Fundamentally Sound

By Robert E. Horton
Consulting Engineer, Vorheesville, N. Y.

ABOUT 30 years ago a theoretical analysis of runoff was published by Lueger, and it was shown that for certain assumed conditions surface-runoff graphs are approximately triangular in form. It may now be considered as established that the triangular form results under all conditions except for very long-continued rains. This fact is not, however, essential to Mr. Sherman's method. The essential thing is that the form of runoff graph is in a large measure a definite physical characteristic of the drainage basin, varying but little with rainfall-intensity distribution except under extreme conditions but, of course, varying to a wide extent in the case of long storms with varying amounts of rainfall on different days.

That the unit-graph method permits estimates of streamflow to be made from rainfall alone, which are in fair agreement with actual gagings, is evidenced by the illustrations accompanying Mr. Sherman's paper.

So far as the writer is aware, no other method has ever been developed or even suggested that would accomplish similar results. The method unquestionably represents an important contribution toward the solution of the fundamental problem of the analysis of the hydrograph and a distinct advance in hydrologic practice in computing runoff.

Runoff consists of two parts: direct surface runoff and groundwater supply to streams. Confining attention at present to the phenomonen of surface runoff from a more or less permeable area, it may be noted that all natural ground surfaces are somewhat rough and contain numerous minute depressions and sometimes larger depressions. Surface runoff represents approximately that part of the rain which falls at a rate exceeding the rate of infiltration over the drainage area. On any part of the area where the infiltration capacity exceeds rainfall rate no surface runoff occurs. Also, at the beginning of a rain, little or no surface runoff occurs until the innumerable small depressions on the surface have been filled and begin to overflow. Practically there are nearly always wide variations in the infiltration rate on different parts of a drainage basin, so that the land-surface-runoff rate generally increases as the rain intensity increases. When rain ends there remains on the ground surface a certain depth of water in transit to the stream, together with water impounded in minute pockets and depressions. Part of this runs off from the surface after rain ends, and the remainder enters the ground as infiltration.

One conclusion of the writer's study has been that the form of the runoff graph resulting from a given storm is developed almost entirely on the ground surface before the water reaches the

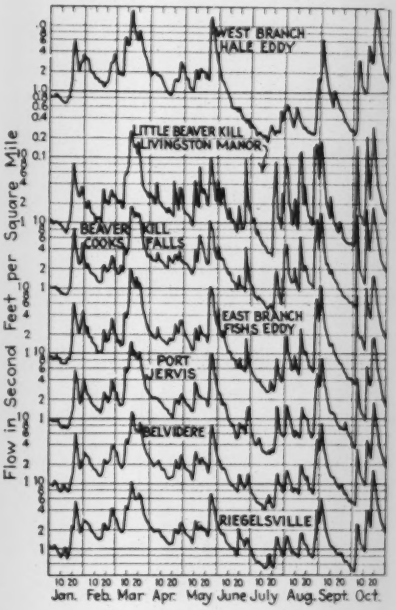

Flow in Second Feet per Square Mile
WEST BRANCH HALE EDDY
LITTLE BEAVER KILL LIVINGSTON MANOR
BEAVER KILL COOKS FALLS
EAST BRANCH FISHS EDDY
PORT JERVIS
BELVIDERE
RIEGELSVILLE
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct.

Fig. 2—Comparison of the hydrographs recorded at gaging stations on the Delaware River indicates that unit runoff derived for one station can be applied to other locations on the same stream.

stream, and the runoff graph is very little modified (except in case of very long intervals) by channel flow thereafter. The runoff graph at a given gaging station is therefore virtually a summation of the runoff graphs from the different unit areas of ground surface that contribute to the stream.

The writer's investigations also indicate that in general the velocity of channel flow is sufficiently constant after a certain stage is reached so that the application of the unit graph, unchanged in form to any given rainfall that produces a considerable volume of runoff, appears to be reasonably justified. This point, however, requires further investigation.

Another result of the writer's theoretical studies is that the effects of variation in rain intensity for that part of a given rain for which the intensity exceeds the infiltration rate are largely

integrated and eliminated by surface detention or sheet flow, so that, subject to some limitations, variation in rain intensity throughout a given unit time interval can often be neglected without serious error. If, as appears probable for storms giving substantial volumes of runoff, the use of the unit graph automatically eliminates the vexed question of estimating time of channel transit and effect of channel detention, then it seems clear that there is little left but rainfall and infiltration to be taken into account.

Interesting confirmation of these important facts is afforded by the accompanying diagram (Fig. 2), which shows hydrographs at various stations on the Delaware River, all reduced to the basis of second-feet per square mile. The uppermost line indicates the runoff of the West Branch of the Delaware River at Hale Eddy. The next diagram is that of the Little Beaverkill, a small tributary of the East Branch of the Delaware River. Beginning with this line and following down to the bottom of the diagram, it will be observed that with rare and minor exceptions every variation in runoff at one gaging station is reflected in the hydrographs at all the others, although the drainage areas range from 25 to 6,190 square miles. In general, the runoff peaks (in second-feet per square mile) decrease more or less uniformly as the drainage area increases. This reflects the modification of the graph in traversing a long stream channel. The close identity of form of corresponding runoff peaks at different stations suggests that a unit runoff derived for a given station on a stream can, with some modification, be applied also to other locations on the same stream.

In the case of the Big Muddy and Delaware rivers Mr. Sherman uses records for only two rainfall stations. For the latter stream, at least, many more records are available. The question naturally arises whether the results obtained would have been equally good or better if all available rainfall records had been used. Obviously the labor of runoff computation by Mr. Sherman's method can be greatly lessened if it is found possible in case of large areas to use rainfall records for only a limited number of index stations. At present the writer is of the opinion that, where rainfall stations are as sparse as they are in the United States, all available rainfall records known to be reliable should be utilized. The desirability of taking into account all available rainfall records is specially evident in cases where the rain covers only part of a drainage basin or varies greatly in amount on different parts of the drainage basin.

It may appear that Mr. Sherman's method fails for long periods of drought, since there is then no rainfall from which to compute the runoff. For such periods a second unit graph is needed, and such a graph can be obtained from a record of flow of the stream for a long period of no rainfall—i.e., by using a groundwater-depletion curve.

In the spring of 1903 a long period of drought occurred in eastern New York, and from the runoff graphs of certain streams obtained at that time the writer concluded that runoff could be reliably computed in periods of no rainfall from groundwater-depletion curves. This method has been in use in the writer's practice since that date. In 1904 a theoretical analysis was made by the writer, which shows that the depletion curve is closely represented by an inverse exponential curve of the from $q = a\,e^{-kt}$, where q is the rate of streamflow at time t after the last rain, a, a constant representing the initial volume of groundwater storage, with k also a constant. Later investigations indicate that the law of groundwater supply is the sum of two or perhaps three somewhat similar terms. This method of computing runoff in periods of no rainfall may now be considered well established. So far as covered by Mr. Sherman's paper it is represented by his "base curve of runoff."

The method is, however, still in a formative stage. It will become useful only to the extent that adequate data for its application are compiled and published. It is to be hoped that engineers and hydrologists will cooperate in the collection and publication of reliable data of rainfall and runoff on different drainage basins in such form that they may both be correlated with the physical characteristics of the drainage basins and used as a basis of development and application of Mr. Sherman's method.

* * *

Method Is Checked by New England Streams

By Cecil Boling
Chicago, Ill.

STUDENTS and engineers have long understood the need of a scientific approach to streamflow problems. The unit-graph method amply satisfies, in part, this need.

The hypothetical and actual hydrographs given for illustration in the article show fair agreement. If more consideration were given to the variation of rainfall intensity over the drainage area, both in the construction of the unit graph and its use with given precipitation data, the two hydrographs would more nearly coincide.

Mr. Sherman has given much detailed attention to the determination of base flow and the effect of intervening rains. It seems just as accurate, if not more so, to draw at the base of that portion of the hydrograph used for the unit graph a straight line almost horizontal, and to deduct from the noted discharges above this base line certain values to take care of the intervening rains. The slope of the base line as well as the values to be deducted should be ascertained by a careful study of the actual hydrograph when no rainfall had occurred and a study of the peak discharges preceding and following the unit-graph peak.

The unit graph has been applied to the Merrimack River at Franklin Junction, N. H., and the Connecticut River at White River Junction, Vt. In each case, by using almost a 100 per cent runoff factor for the weighted precipitation, the calculated peak discharges for the flood of November, 1927, were very close to the measured peaks. The results of these two cases indicate that it is impracticable to estimate the total flood period for any drainage area. It may also be noted that the agreement obtained between an actual hydrograph and one computed from a unit graph gives some proof that the total flood period for any given area is a constant.

By perfecting the unit graph method and by devising rational means for estimating runoff—something yet to be done—streamflow problems may be attacked on a scientific basis.

* * *

Variability of Watersheds Presents Great Weakness

By George D. Clyde
Associate Professor of Civil Engineering, Utah State Agricultural College, Logan, Utah

I THINK the unit-graph method of estimating streamflow may have some merit in studying runoff due to rainfall. However, there appear to me to be several fundamental weaknesses in the method.

1. Rainfall is never uniform over wide areas.

2. Runoff is not a percentage of rainfall. The unit-graph method is based upon the assumption that the runoff is a percentage of the rainfall.

3. Ground storage is not considered.

4. The method would not be applicable to runoff from precipitation that has been stored in the form of snow, due to the fact that the time of runoff and the length of the runoff period is largely a function of temperature.

The character of precipitation in an arid region and also the runoff characteristics of arid streams vary over wide ranges. I think it would be extremely difficult to apply the unit-graph method to compare the runoff sequence from precipitation on our Western watersheds. I believe every watershed is a law unto itself and the precipitation-runoff relationship must be worked out for each individual case. The basic relationship is that runoff is equal to the precipitation minus the losses.

The method does, however, appear to offer considerable promise in studying runoff from a sequence of rainfalls and for computing the runoff from storms of different intensities. The time of concentration and the effects of surface storage can also be conveniently studied.

Rock Island Lift Bridge Erected on Old Fixed Spans

New bridge is on same line but 12 ft. higher and planned for future raising of grade—Traffic is uninterrupted on Rock Island Railroad main line

RECONSTRUCTION of the bridge of the Rock Island lines over the Des Plaines River and the Illinois & Michigan Canal, at Joliet, Ill., presented special problems and difficulties in both the design and the erection of the new structure. It was necessary to retain the original alignment but to raise the grade 12½ ft. and to replace the old five-span fixed structure with a lift span and two fixed spans, all this work to be done while maintaining traffic on a busy double-track main line. The design has also to provide for future increase of minimum headroom for navigation, which will necessitate raising the piers and abutments. Furthermore, a novel situation imposed upon the design was the necessity of providing for a future increase in the headroom of the lift span to 109½ ft. when open, in the event of the waterway being utilized by vessels needing more than the present 59½-ft. headroom. To meet this requirement, the towers are designed for raising their present three bays 50 ft. and inserting two new 25-ft. bays under them, seated on the fixed trusses. —EDITOR.

REPLACEMENT of several fixed bridges with drawbridges is one of the requirements of the U. S. government in providing for navigation on the future Illinois Waterway, which is to connect the Great Lakes with the Mississippi River. The most important structure included in this reconstruction program is the new lift bridge of the Rock Island lines at Joliet, Ill., crossing the Des Plaines River (which will be a link in the waterway) and also the adjacent Illinois & Michigan Canal. The bridge takes the place of a fixed structure and is on the same center line but has its rail level 12½ ft. above that of the older bridge. The general situation is shown in Fig. 1.

A new dam with lock, in the Des Plaines River just below Joliet, built as part of the waterway project, has raised the normal and flood levels of the river to within 3.2 and 2.2 ft., respectively, of the old bridge floor. This change necessitated a raise in grade to give headroom for small craft and also a lift span to permit the passage of larger boats. There is little traffic in the old boat canal and none in the river as yet, since the waterway is not completed.

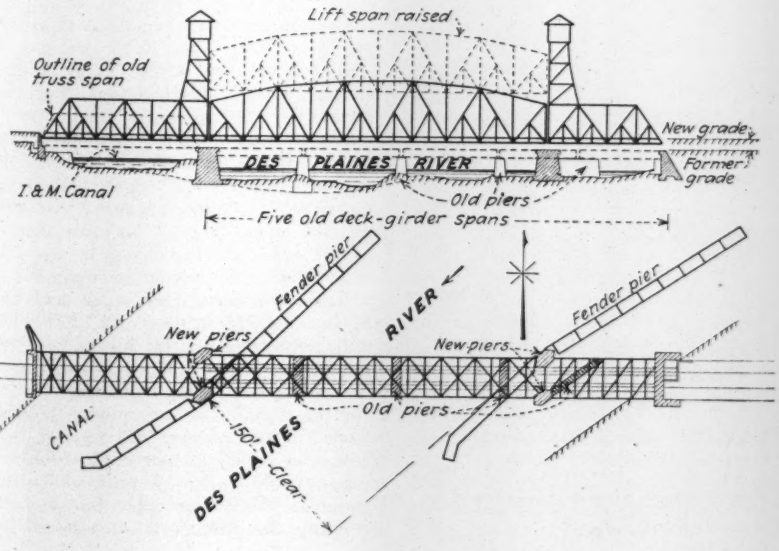


Fig. 1—Rock Island Railroad builds new lift bridge at Joliet on top of girder spans of old double-track bridge.

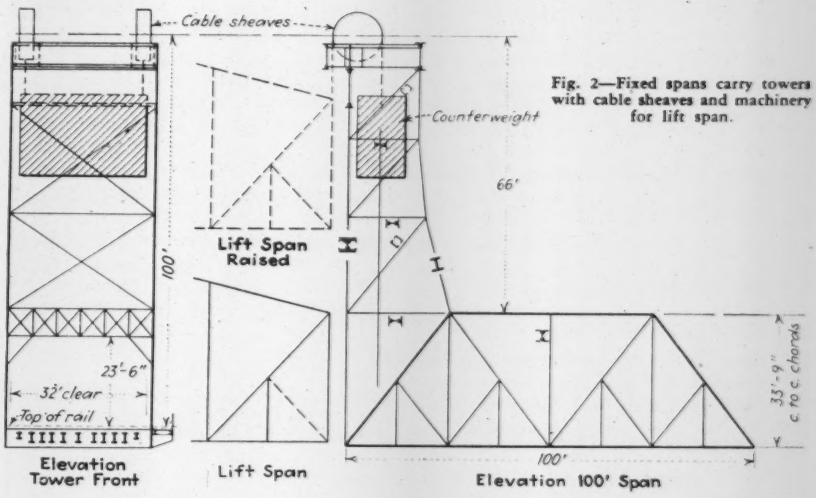


Fig. 2—Fixed spans carry towers with cable sheaves and machinery for lift span.

The old double-track bridge, built in 1900 and designed for two 154-ton engines, or slightly less than Cooper's E-44 loading, had a total length of 565 ft. between back walls, including five deck-girder spans of 51 to 91 ft. across the river and one 153-ft. through-lattice truss span over the canal, which is close to the west bank of the river. The girder spans were originally double-track units, with four lines of girders, but the connecting cross-struts were cut with torches to facilitate the change of grade by handling each track separately. However, the truss span had to be raised as a unit.

New bridge has lift span

For the new structure a three-span arrangement was adopted, having a vertical-lift drawspan of 302 ft. flanked by two through-truss fixed spans, 150 ft. at the west end and 100 ft. at the east end. These fixed spans support the towers for the lift span. Owing to the severe skew of the crossing, which is 38 deg. 46 min., this length of the lift span was necessary to give the specified clear waterway of 150 ft. measured at right angles to the channel. The length of the flanking spans was fixed by the position of the waterfront bulkheads or retaining walls built by the U. S. government. A headroom of 9½ ft. is provided with the lift span closed and 59½ ft. when it is raised, but provision had to be made for increasing the headroom to 16½ ft. with the span in lowered position and to 109½ ft. with the span raised.

Besides heavy train traffic the bridge carries frequent switching movements between the railway yards on the west side of the waterway and the freight houses, team yards and industries on the east or city side. In addition, while the original alignment was retained it was not considered desirable to put falsework in the river to support the lift span during erection. Under such a combination of conditions and limitations it is evident that there were exceptional prob-

lems and difficulties in designing the bridge and in planning and executing its construction.

All spans are riveted through-trusses of the subdivided Warren type, designed for Cooper's E-65 loading and conforming to the general specifications of the American Railway Engineering Association. The trusses are spaced 35 ft. 2 in. c. to c. to provide for two tracks, each having a gantlet track with rails 12 in. apart over the gage lines. This unusual arrangement is to permit of switching movements on the gantlet tracks without operating all the main-line switches and signals. At present, however, only the main tracks are laid, with the usual inside guard-rails. A 6-ft. sidewalk for employees is carried on cantilever brackets outside the north line of trusses. Silicon steel is used for the truss members and floor beams of the lift span, with the exception of some minor members; it is used also for the floor beams of the fixed spans. With this material the weight of the lift span was reduced considerably, while other factors made the use of silicon steel highly desirable.

Steel towers built integrally with the fixed spans support the 13-ft. cable sheaves of the lift span and also carry the operating machinery, with a height of 100 ft. from the center line of the bottom chord to the center line of the sheave bearings. On the fixed spans a 7-in. concrete deck was poured on 26-in. I-beam stringers and carries ballasted tracks, but the lift span has the usual open-floor construction to reduce the weight. The 100-ft. fixed span with tower is shown in Fig. 2.

Masonry provides for alterations

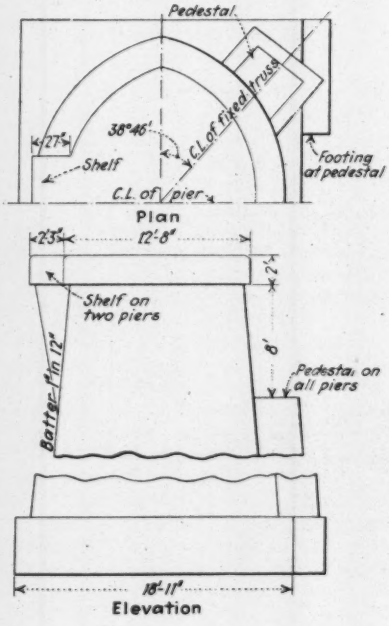
Foundation work consisted mainly in clearing the soft and loose top portion of the bedrock that here forms the bottom of the river and the canal. Two abutments and four piers, all of concrete, constitute the substructure. Two piers at each end of the lift span were required, as a single long pier set square with the bridge would have been an undesirable obstruction to the river flow.

Substructure construction was complicated by the fact that both abutments and the two west piers were to occupy the same positions as the old work. This made it necessary to support the old spans on falsework at these points while the masonry was removed and rebuilt. In the east abutment is a 10-ft. conduit forming part of an intercepting sewer built into the river wall to carry the city's sewage below the Brandon Road dam. The west abutment provides for a similar 5-ft. interceptor. Fender piers of rock-filled timber cribbing parallel the channel and protect the bridge piers, waling timbers being bolted to the faces of the piers. All pier footings are extended on the land side to support future jacking bents under the first half-panel posts of the fixed spans.

Provision for a future increase of 7 ft. in height of the masonry is a special feature in the design of the piers, abutments and retaining walls. To enable the spans to be raised to the new elevation while the additional masonry is being built, each cylinder pier is formed with a pedestal projection on the land side and in line with the first half-panel post of the fixed span. The tops of these pedestals are below the tops of the piers to allow of placing a raising truss when it is necessary to raise the bridge. In addition, the south cylinder pier at the east end and the north cylinder pier at the west end have each a shelf projection level with the top of the pier. Owing to the shape and location of the piers, these projections were necessary to form a support for the buffers of the lift span. In emergency they may serve also for placing 500-ton jacks if a release of the counterweight or any adjustments to the lift span should be required. In Fig. 3 is shown one of the four lift-span piers having both the pedestal and shelf construction.

In raising the abutments and retaining walls their extensions not only will rest on top of the old work but will extend down the rear side to a footing at the level of the present fill. Holes will be drilled for dowels and for hook-end expansion bolts to which the new reinforcing bars will be attached. With the new structure 12½ ft. higher than the old bridge, it was necessary to raise the earthfill approaches and to give runoffs of 0.5 per cent to meet the old grade. This fill necessitated increasing the grades of leads to adjacent industries and in some cases building new reinforced-concrete walls of the counterfort type to take care of the difference in elevation between the leads and the main tracks. To provide for future increase in the height of these walls, a 3-in. hole is cored near the top of each counterfort, so that a pin can be placed to receive the hooked ends of reinforcing bars in the future addition.

Fig. 3—Projections on piers provide for future raising of grade on bridge.



Lift spans and cables

In many vertical-lift bridges the operating machinery is mounted on the lift span, with continuous cables extending from the engine drums to guide sheaves at the end of the span up to the sheaves on top of the towers and then back to the drums. The cables carrying the counterweights were then independent of the operating cables. The first departure from this arrangement was made by the Rock Island lines in the White River bridge at DeValls' Bluff, Ark., built in 1927 (*ENR*, Nov. 3, 1927, p. 705). In that case the machinery was mounted on top of the towers, and power was applied directly to the sheaves of cables that had one end attached to the lift span and the other to the counterweight. The span was thus relieved of the machinery load, and the cable equipment was much simplified.

This direct-lift plan, since used at other bridges, is followed in the Des Plaines River bridge. To each corner of the span are attached sixteen cables 2¼ in. in diameter, which pass over the 13-ft. driven sheaves (12 ft. 9 in. diameter in the rope grooves) and down to the counterweight. All the sixteen cables are side by side on the sheave, but just above their attachments to the lifting girder and the counterweight box they are separated into two groups by a spacing block. The cable sockets are held by 4½-in. pins in connection plates, which in turn are attached to the span and the counterweight by 10-in. pins. These cable attachments are shown in Fig. 4. In place of the usual portal girder there is the lifting girder, of double-web or box construction.

No equalizing devices are used in the cable connections to equalize the loads on the sixteen cables after erection, as was done at the White River bridge. Instead it was specified that all cables should be cut to exact length while under a stress equal to 2 per cent of their ultimate strength, the cable to be supported for its full length while being measured. It was considered that with exactly equal lengths between centers of pin holes the difference in stress in individual cables would be negligible.

Each counterweight is a steel box 31 ft. long, 21½ ft. deep and 12 ft. wide, with pockets on top for blocks to adjust the exact weight. The lift span is estimated at 1,235 tons, including 178 tons for the deck. The two counterweights have 116 tons of steel, 981 tons of plain concrete (144.6 lb. per cubic foot), 75 tons of old rails, 19 tons of cement grout at 130 lb. per cubic foot for embedding the rails, and 44 tons of ad-

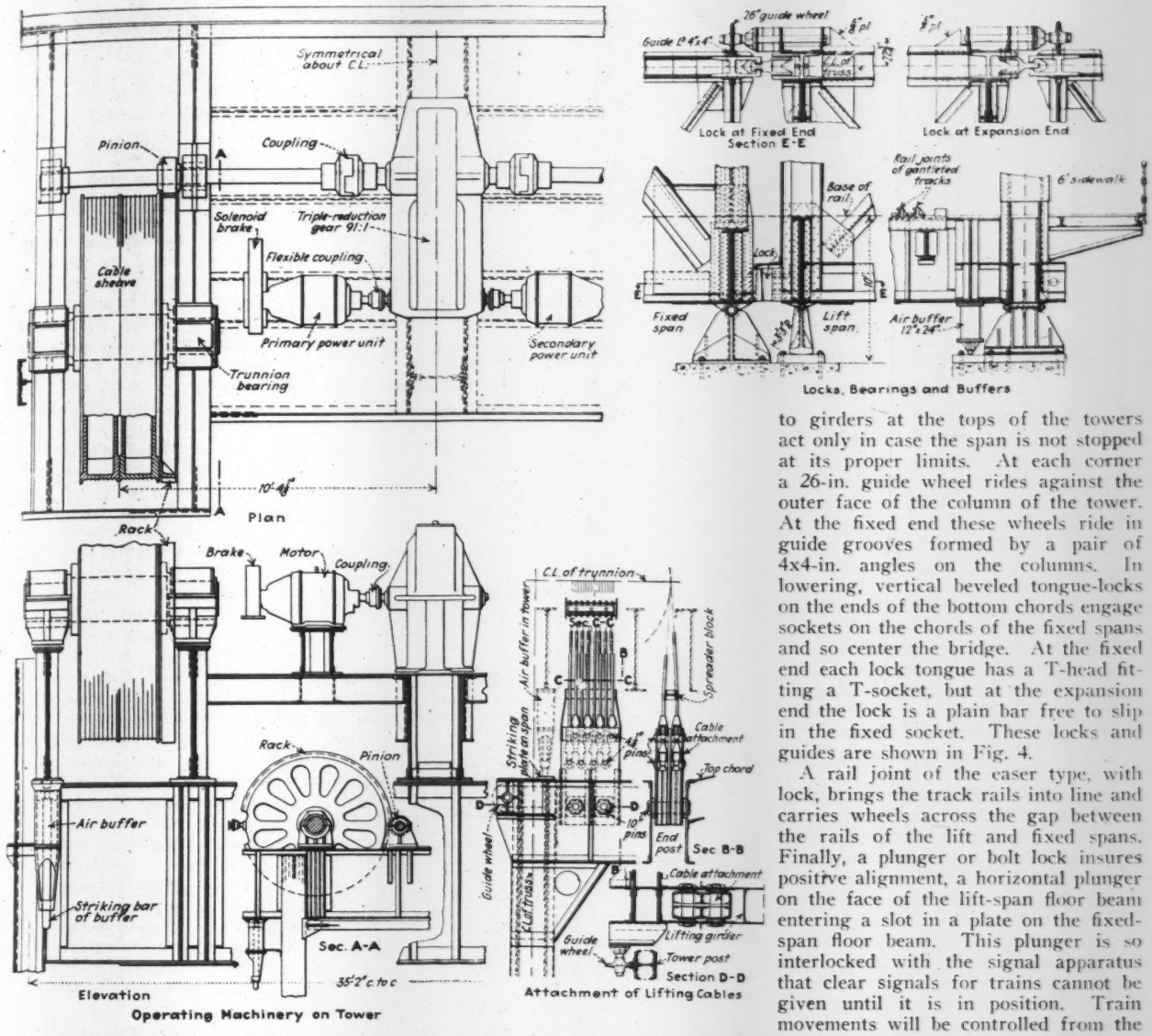


Fig. 4—Operating machinery is placed on towers on fixed spans with lifting cables attached to movable span without equalizers. Cable sheaves are motor-driven through ring gears.

justment blocks. These blocks, 15x20x 13 in., are of concrete loaded with steel punchings and estimated to weigh 440 lb. each. When the bridge is raised the counterweights form effective barriers across the ends of the fixed spans.

Lift-span operation

On each tower are two 13-ft. 37-ton sheaves, each grooved for sixteen cables. They are covered by sheet-iron housings. At one side of the sheave is a ring gear or circular rack. Two 75-hp. motors are connected through a triple speed-reducing gear to a shaft carrying two pinions that engage the circular racks on the sheaves, as shown in Fig. 4. One of the motors operates as a driving motor and the other as a synchronizing or tie motor to keep the span level while being raised and lowered. But the tie motors can be used as driving motors in case of failure of the latter. Each motor is equipped with solenoid brakes; these act as service brakes on the driving motor and as emergency brakes on the tie motor. Both motors and brakes at each end are controlled from the operator's cabin on the ground at the east end of the bridge. The brakes are so connected that besides operating with their respective motors, either one can be operated independently from the cabin as an emergency brake while its corresponding motor is running idle.

Current is supplied by a local utility company, a cable laid across the channel connecting the two sets of motors and the control cabin. The machinery is designed to raise the bridge 50 ft. in 105 seconds. As the bridge nears the bottom of its travel it is cushioned by compressed-air buffers under the end floor beams. Similar buffers attached to girders at the tops of the towers act only in case the span is not stopped at its proper limits. At each corner a 26-in. guide wheel rides against the outer face of the column of the tower. At the fixed end these wheels ride in guide grooves formed by a pair of 4x4-in. angles on the columns. In lowering, vertical beveled tongue-locks on the ends of the bottom chords engage sockets on the chords of the fixed spans and so center the bridge. At the fixed end each lock tongue has a T-head fitting a T-socket, but at the expansion end the lock is a plain bar free to slip in the fixed socket. These locks and guides are shown in Fig. 4.

A rail joint of the easer type, with lock, brings the track rails into line and carries wheels across the gap between the rails of the lift and fixed spans. Finally, a plunger or bolt lock insures positive alignment, a horizontal plunger on the face of the lift-span floor beam entering a slot in a plate on the fixed-span floor beam. This plunger is so interlocked with the signal apparatus that clear signals for trains cannot be given until it is in position. Train movements will be controlled from the present interlocking tower at the Joliet station, about 2,000 ft. from the bridge.

To raise the bridge, it is necessary first to set the signals against trains in both directions and to energize the bridge interlock relay by means of the interlocking lever. This permits power to be applied to the bridge controls and prevents clearing the signals. A master switch in the operator's cabin controls the raising and lowering of the bridge. When fully raised, a limit switch cuts off the power and sets the service brakes on the driving motor. As the span approaches its lowered position, it is similarly controlled and is then seated by operating a pedal switch that provides only a low power. Signal lights indicate when all four corners are seated on their bearings.

If one driving motor should tend to slacken the speed and so tend to keep its end of the span lower than the other, there will be a flow of current from the opposite driving motor to equalize the

power. The tie motor of the latter or leading motor then acts as a generator, thus increasing the load and tending to slow down the leading motor. At the same time the other tie motor acts as a motor to supply power to the shaft and so supplement the lagging driving motor. Should the span get out of level, a switch cuts off power before it can bind in the guides or cause any damage to the guides or guide wheels.

Raising grade under traffic

Raising the bridge and approach tracks 12½ ft. to the new grade was the first step. On the girder spans each track could be raised separately, the connecting cross-struts having been cut apart; but the double-track truss span had to be handled as a unit. It was decided to utilize the old spans as falsework for erecting the new spans, as the swift current and the dangers of drift and ice made it undesirable to carry the steel on falsework.

The old double-track 153-ft. truss span was raised 12½ ft. by jacking in 12-in. lifts at opposite ends alternately, the span being supported by blocking after each lift. Four 100-ton pneumatic jacks were used for this purpose. At its shore end the approach tracks were raised in corresponding lifts of 12 in. on ballast. At its river end the adjacent girder span was also raised correspondingly, and the following girder spans of one track were raised successively so as to form a runoff from the truss span. Both tracks were put in service for traffic each night. The new trusses were erected on falsework after the old trusses were removed. The floor beams and stringers were placed after removal of the old floor beams and stringers within the limits of the new construction.

The girder spans, however, were raised only 6 ft. and then remained supported by blocking on the piers. They were handled by a locomotive crane, the spans being lifted in succession for one track while the other track was kept open for traffic. When all the girder spans of both tracks had been raised 6 ft., the jacking of the truss span was resumed for the additional 6½-ft. rise. A pile pier was built up under the middle of each girder span to reinforce it for the additional load of blocking and new steel. Blocking was then built up for 6½ ft. on the girder spans to carry temporary tracks on timber stringers.

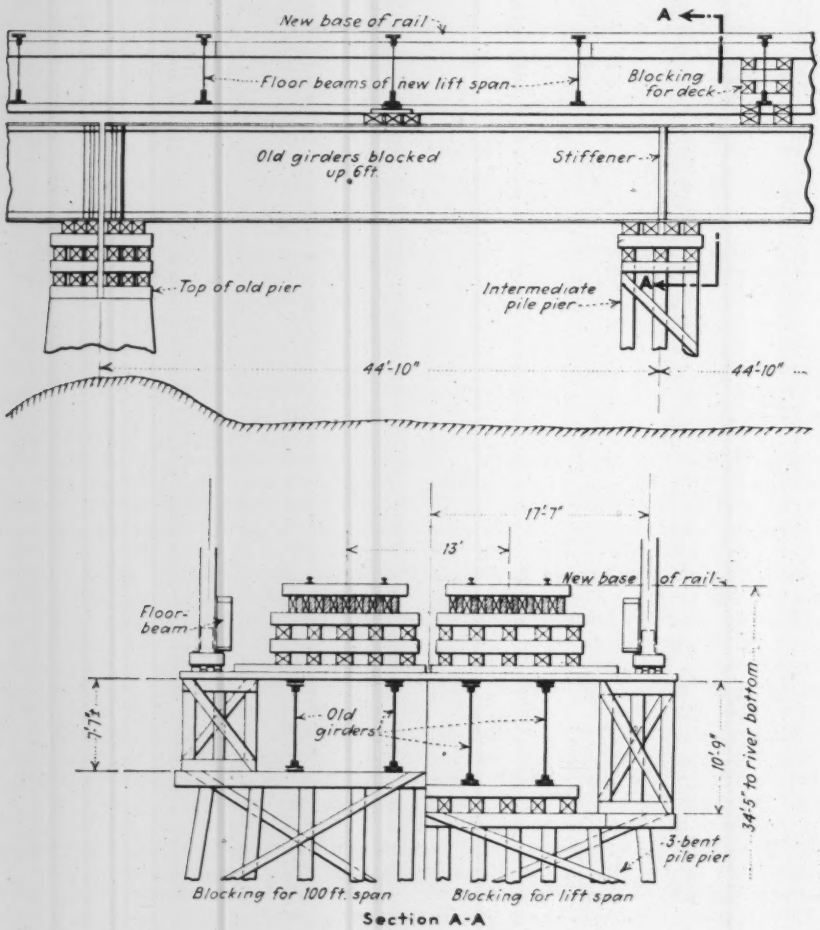
Falsework for the new 150-ft. fixed span over the canal consisted of pile piers supporting wood and I-beam stringers covered by a deck on which the bottom chords and floor beams were erected on blocking. A 20-ft. span with a fender on each side provided for the passage of boats. The blocking for the lift and fixed spans is shown in Fig. 5.

The plan of raising the girder spans only 6 ft. and then raising the track an additional 6½ ft. by blocking on the girders was adopted to keep the girders below the level of steel in the new bridge and thus to facilitate the placing of the floor beams and bottom chords. The blocking on the girders was so arranged in sections as to permit of its removal before placing the new floor beams. Two panels of floor could be set in an eight-hour working day, utilizing periods of 40 min. to one hour between trains. As soon as both tracks were cut, a panel of falsework was removed to allow the erection of a 13½-ft. panel of floor, including a 6-ton floor beam and eleven I-beam stringers. To close the opening between the new steel and the next crib of blocking, portable timber bents with timber chords were used. The track ties and rails were then replaced, and the track was opened.

The 6 ft. 8 in. of cribbing and stringers on top of the old girders allows for the depth of the new floor beams and the camber blocking. The cribs were placed so as to be clear of the positions for the floor beams. The erection equipment consisted of a 50-ton and a 60-ton locomotive crane, and a 50-ton stiff-leg derrick set on top of the lift span for erecting the towers and machinery. All switching of cars of material was by locomotive cranes.

One track at a time was given over to the work for a certain period, all traffic being handled over the other track. Temporary crossovers were laid to facilitate movements of trains and the work train. A telephone booth at the bridge was connected with the dispatcher's office at the station and with cabins of the switchmen at both ends of the bridge, thus avoiding delays to trains, except that speed was reduced in passing over the structure.

Fig. 5—Old girders blocked up on piers and intermediate bents support blocking for new truss spans.



Section A-A

Engineers and contractors

This bridge design and reconstruction was carried out under the direction of W. H. Petersen, chief engineer, and I. L. Simmons, bridge engineer, of the Rock Island lines, with H. E. Johnson as resident engineer. The Herlihy Mid-Continent Co., Chicago, had the general contract and handled the substructure work. Raising the old bridge and erecting the new spans was sublet to the F. K. Ketler Co., Chicago. The steel, machinery and electrical apparatus were furnished by the American Bridge Co. Track work and the raising of the approach fills were done by the railway company. The bridge was completed, except for its electrical equipment, in October, 1931.

Contract-Operated Destructor Plant to Revert to City in Ten Years

Agreement signed in Baltimore involves incineration of rubbish and garbage and collection of rubbish by private contract, with payments made monthly on unit-price basis

IN CLOSING an agreement with E. T. Foreman Co. the city of Baltimore has entered into an unusual arrangement for the disposal of its municipal refuse. Under the terms of the contract the company is to construct and operate for ten years a 600-ton-daily-capacity incinerator plant for the destruction of garbage and rubbish and is to receive compensation in monthly amounts based on the quantities of the material burned. At the expiration of the ten-year period the ownership of the incinerator plant is to revert to the city. An additional item in the contract provides for the collection of rubbish for a five-year period, with monthly payments also based upon the amount of material collected. A brief account of the letting of the contract was published in *Engineering News-Record*, July 21, 1932, p. 91.

Incineration as a method of disposal of garbage is new in Baltimore, although the general problem of disposal has been under discussion there for the past 40 years. Garbage has been disposed of by dumping, by reduction, by feeding to hogs and by sale to a contractor for disposal as fertilizer; rubbish has been disposed of by dumping and, within recent years, by incineration.

Since 1921 garbage has been handled in the reduction plant of the Sanitary Reduction Co.; collection has been by municipal forces. In 1924 a rubbish incinerator with a design capacity of 175 tons per day was constructed by the city. A second rubbish incinerator, of 250-ton capacity, was built in 1927. Rubbish has been collected by the E. T. Foreman Co. on contract at $5.75 per ton. The recent situation, therefore, has been one of municipal collection of garbage with private disposal and contract collection of rubbish with municipal disposal.

TABLE I — GARBAGE AND RUBBISH COLLECTED IN BALTIMORE

Year	Tons of Garbage	Tons of Rubbish
1922	47,961	.....
1923	53,484	.....
1924	50,760	.....
1925	54,480	.....
1926	56,400	.....
1927	60,747	46,384*
1928	67,576	83,103
1929	72,176	97,450
1930	71,893	111,081
1931	79,508	130,123

*Part of city only

The contract with the Sanitary Reduction Co. for garbage reduction expired on Dec. 31, 1931, and the contract with the E. T. Foreman Co. for the collection of rubbish expired on Aug. 12, 1931. When the necessity came to make new provisions for garbage disposal, incineration was favored by the municipal authorities. The existing incinerators are not suitable for the destruction of garbage but can be made so by some reconstruction. Pending the completion of such reconstruction, it became necessary to provide facilities for handling all the refuse collected from the city at one point. Thereafter the new incinerator plant and the two old ones could all be used for refuse (garbage and rubbish).

However, regardless of the estimated saving of such a plan over the cost of existing methods of disposal, the city considered it inexpedient to undertake the financing necessary for the construction of a destructor plant or the purchase of new collection equipment. Accordingly, it was decided that disposal should be carried out on a contract basis and that rubbish should be collected by the same company, relieving the city of any financial obligations other than the monthly payments for the work performed.

A plan was devised, and a contract and set of specifications were drawn up accordingly for the construction of a high-temperature destructor plant suitable for the incineration of both garbage and rubbish, to be built on city-owned property in the Patapsco River and to have a daily capacity of 600 tons of combined refuse. The contract provides that the contractor shall receive compensation monthly in accord with (1) the amount of garbage incinerated, with a guarantee of 70,000 tons per year, (2) the amount of rubbish incinerated, with a guarantee of enough material to facilitate garbage incineration, and (3) the amount of rubbish collected.

The city is to continue collecting garbage and will deliver it to the incinerator plant. Of the rubbish collected by the contractor enough is to be diverted to the new plant to represent at least 35 lb. for each 65 lb. of garbage delivered, and the remainder is to be delivered by him to the existing rubbish incinerator. During past years the records of the city show that the amount of garbage and rubbish collected was as shown in Table I.

Under the terms of the agreement the contractor is obligated to provide a plant that will satisfactorily evaporate and incinerate garbage and rubbish mixed in those proportions, regardless of the moisture content of the material or of the weather conditions prevailing during the collection and hauling. The contract further provides that an average temperature of not less than 1,450 deg. F. is to be maintained in the combustion chamber of the incinerator, and that it shall never fall below 1,200 deg. F. for more than 10 min. in any hour. Also there is to be no smoke escaping from the chimneys or any nuisance created through the escape of odors, gases, sparks or dust. All material, except incombustibles, must be reduced to a mineral ash containing not more than 1 per cent of carbonaceous material.

The contractor is to maintain the incinerator plant in first-class condition throughout the term of the contract. Three months before its expiration the city's engineer will make a general inspection of the plant for the purpose of ascertaining its condition and, if necessary, will require the contractor to make repairs and renewals.

Although the choice of equipment is left to the contractor, as is the detailed design of the building that he is to con-

TABLE II — BIDS FOR DISPOSAL OF GARBAGE AND REFUSE

	Tons	E. T. Foreman Co. Unit Price	E. T. Foreman Co. Amount of Bid	Potts-Callahan P. C. Street Corp Unit Price	Potts-Callahan P. C. Street Corp Amount of Bid	Baltimore Incinerator Corp. Unit Price	Baltimore Incinerator Corp. Amount of Bid	Baltimore Waste Disposal Co. Unit Price	Baltimore Waste Disposal Co. Amount of Bid
Collection and hauling of rubbish	120,000	$4.10	$492,000.00	$3.33	$399,600.00	$4.20	$504,000.00	$3.25	$390,000.00
Incineration of rubbish	44,000	.80	35,200.00	1.72	75,680.00	1.78	78,320.00	1.52	66,880.00
Incineration of garbage	80,000	1.85	148,000.00	2.48	198,400.00	2.54	203,200.00	3.16	252,800.00
Total for 1 year			$675,200.00		$673,680.00		$785,520.00		$709,680.00
Collection and hauling of rubbish, 5 years			2,460,000.00		1,998,000.00		2,520,000.00		1,950,000.00
Incineration of rubbish, 10 years			352,000.00		756,800.00		783,200.00		668,800.00
Incineration of garbage, 10 years			1,480,000.00		1,984,000.00		2,032,000.00		2,528,000.00
Total for entire contract			$4,292,000.00		$4,738,800.00		$5,335,200.00		$5,146,800.00
Estimated cost of building			$415,000.00		$500,000.00		$432,000.00		$480,000.00
Kind of incinerator			Pittsburgh Des Moines				Hiler		Decaire

struct, the important general features of the plant are rigidly defined in the specifications. The furnaces are to be of the top-feed type and are to be set up in a straight line. Each unit is to be provided with facilities for supplying and injecting fuel oil into the furnace to aid combustion when the moisture content of the mixed refuse is too high to allow normal burning. The furnaces are to operate under forced draft with preheated air. Each combustion chamber is to have a minimum volume of 15 cu.ft. per square foot of effective grate area, and the rating of the grate must be not more than 70 lb. of mixed refuse per hour per square foot. A drying hearth is to be provided with an area at least half that of the effective grate area. Two chimneys are to be provided for the building, and they are rather rigidly specified.

On June 15 bids were received from four contractors. The low bid was $4.10 per ton for the collection and hauling of rubbish, 80c. per ton for the incineration of rubbish and $1.85 per ton for the incineration of garbage, or on the estimated quantities a total annual charge of $675,200. A complete tabulation of bids is as shown in Table II. The contract was awarded to the E. T. Foreman Co. on July 15.

The drafting of the contract and specifications and the supervision of the collection and disposal of the municipal refuse come under the Department of Public Works, of which Bernard L. Crozier is chief engineer.

Cores Reveal Effectiveness of Paving Dummy Joints

Specimens from first joints placed in Seattle eleven years ago show that device functions as planned

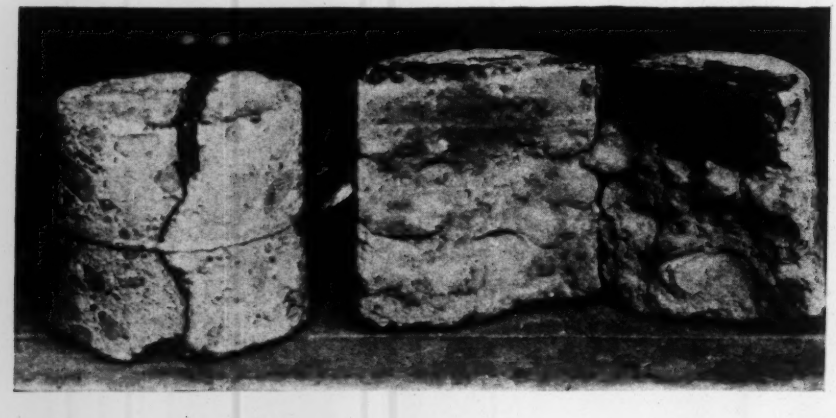
By H. F. Faulkner
Junior Engineer, City Engineer's Department, Seattle, Wash.

AFTER eleven years of service the first concrete-paving dummy joint laid in Seattle, Wash., was cored, and the specimens show that it is functioning satisfactorily as designed. The joints consist of a 2-in. joint filler in the top of the slab, producing a weakened plane at 20-ft. intervals, which subsequently fractures below the filler in an interlocking, shear-resisting joint, without the appearance of a crack on the surface of the paving. The development of this type of joint in Seattle was described in *Engineering News-Record*, April 22, 1926, p. 646. Because of the age of the specimen and the questions that have arisen regarding the effectiveness of this type of joint, the observations resulting from the core tests are believed significant.

The concrete paving was laid on 22d Ave., N.W., Seattle, in 1921, and consisted of a 6-in. slab of portland cement concrete in which was incorporated the dummy or weakened plane joint. It is believed that this was the original installation of this type of paving joint. Traffic has been quite heavy, and there have been no instances of corner or side breaks. The condition of two of the core specimens is shown in the accompanying illustration. The specimen in closed position shows the 2-in. joint filler as set in the slab and beneath it the irregular natural crack through the concrete. The other specimen is opened and shows the interlocking or nesting of the coarse aggregate in the joint. It is interesting to note that neither sheared or loosened aggregate nor evidence of any grinding of the interlocking parts were observed.

Being a longitudinal joint along the center line on the paving, the condition of the fracture beneath the filler is somewhat less conclusive than it might otherwise be. However, there was no trace of dirt, silt or other incompressible material found in any of these specimens except in the ground-up concrete resulting from the coring process. With the top of the fracture closed by the joint filler, which tends continuously to flatten and compress, fine particles of foreign material stop at the pavement surface and do not penetrate this joint deeply.

Core specimens of eleven-year-old dummy joints, showing interlocking fracture.



It is evident that if a sufficiently great separation of the slabs should occur, no shear could be transmitted across a joint of this character. On the other hand, the slight separation that occurs in all but the most exceptional cases, in combination with the elastic deformation of the slab when under load, results in the practical and efficient operation of this joint. Should there be danger of separation of the slab, tierods across the joints could be used.

New Gravity Base Station

A new gravity base station for the entire United States and its possessions has been established in the basement of the new Commerce Building, Washington, D. C., by the Coast and Geodetic Survey of the Department of Commerce. The gravity room of the service is in the basement of the building, about 1 ft. below sea level, and all gravity measurements made hereafter in the United States will be based on the value of gravity in this room.

The old gravity base station for the United States was established in the Coast and Geodetic Survey Building in Washington, D. C. The value of gravity in that room had been determined a little more than 30 years ago by very careful measurements by means of the pendulum apparatus at both that station and at Potsdam, Germany, where the station for the whole world is located.

Before moving out of the old building the Coast and Geodetic Survey established a temporary base station at the Smithsonian Institution by measuring the difference of gravity between the two points. Just recently a new series of very accurate gravity measurements was made betweeen the Smithsonian and the special room in the Commerce Building, and the base station was thus transferred to its new location.

The base station for the United States, therefore, is now well established in a location where it should be safe from disturbance by building operations for many years. The value of gravity at this base station is 980.113 cm. per second squared, as formally announced by the director of the Coast and Geodetic Survey on June 2. This value corresponds to an acceleration of gravity of about 32.156 ft. per second squared.

Letters to the Editor

Floors of Industrial Buildings

Sir—In comment on O. C. Spurling's article on floors (*ENR*, Aug. 18, 1932, p. 191) I have to say that our experience corroborates his in every particular. For fire prevention, and also because so much water is used in our processes, we have not tried to use anything but concrete floors, aside from a mastic coating applied in our machine room. This has behaved exactly as Mr. Spurling says: it is pitted and marked where heavy objects have stood on it, has worn in hollows causing puddles, and even when reasonably level it makes trucks pull too hard for anything but light trucking over it.

Our most satisfactory results have been from concrete floor surfaces finished integral with the slab and having a metallic powder hardener troweled into them during finishing. For patching we have obtained quite satisfactory results by chipping out to a depth of about 1½ in. and using a strong grout with one of the liquid hardeners. On the whole this seems about as satisfactory as reinforcing the surface with grating, though we have several samples of this that are working very well. It is very important in the use of grating to get the sections absolutely level at the points, otherwise these points pound out badly.

We have not had any satisfactory results in the use of asphalt emulsion patching. Patches installed under the producer's own supervision rolled out quickly, and if thicker than about ½ in., they cracked up badly under heavy loads. Workmen object very seriously to them too, as they are soft enought to make trucks pull hard.

The most promising solution we have found on the floor problem is the use of rubber-tired wheels on a number of our two-wheel hand trucks. The tires are tough and elastic but of comparatively soft rubber, and the wheels are fitted with roller bearings. The best testimony is that the men take a good bit of trouble to hold on to one of these trucks when they get it and, as circumstances permit, we intend to continue their installation on all of our manually propelled equipment. H. D. FISHER,

New Haven, Conn.,
July 16, 1932.

Plant Engineer,
The New Haven Pulp & Board Co.

* * *

Sir—Our experience bears out O. C. Spurling's criticisms on asphaltic floors; also the fact that the grain of the wood in aisles should be laid with the direction of traffic. On concrete floors where traffic is heavy we have tried almost everything, but we are still in trouble. Therefore, we are now considering floor guards for the aisles embedded in the concrete.

It would have been interesting to know the cost of the different floors against life, as well as the cost of maintenance. ALFRED VAKSDAL,

Corning, N. Y.,
July 19, 1932.

Plant Engineer,
Corning Glass Works.

* * *

Sir—I have had knowledge of the experience and tests of floors described by O. C. Spurling and am especially glad that this information is now given to your paper for the benefit of the profession in general.

I have examined the King block flooring recently installed in the multi-story building at the Hawthorne works as well as in the one-story building at the Point Breeze works. Apparently these installations compare very favorably with all other floorings that have been installed. We inspected numerous King block and other types of flooring in Chicago, Detroit and Akron before specifying King block for the proposed buildings at the Kearny works, and we shall carefully watch that type of flooring as now installed at the Hawthorne works so as to determine if the specification as drawn should be changed.

We are still of the opinion that for many operations a cement-finish floor is satisfactory and of course is much cheaper than a maple floor on concrete. T. L. CONDRON,

Chicago, Ill.,
July 20, 1932.

Condron & Post,
Consulting Engineers.

Facing Dams With Steel Plates

Sir—Referring to the question of facing rockfill dams with steel plates, M. M. O'Shaughnessy, in a letter published by you, issues a warning against such a makeshift. He mentions that a number of similar dams built in Arizona invariably became crippled because of the expansion of the steel with changes of temperature. As a result of these failures and his own experience with rockfilled dams faced with concrete, he doubts whether the use of steel plates would be any more successful in Colorado than in Arizona.

It seems to me that a consulting engineer should be, above all things, absolutely sure of his stand when making recommendations. Investigation of a dam in Colorado, which was named in an editorial in your issue of May 26, 1932, should have been made by Mr. O'Shaughnessy before he expressed such a decided opinion.

Being greatly interested in the question, I made an investigation, as a result of which I received a letter from Mr. W. N. Clark, president of the Southern Colorado Power Co., which I quote below:

> Your letter to the Pikes Peak Power Co. in Colorado Springs has been referred to me. We are the owners of the Skaguay dam and reservoir, which has a steel face. I personally worked on the construction of this dam in a minor capacity in 1903. The dam was built under the supervision of R. M. Jones, now deceased.
>
> The reservoir is practically empty this summer, and a complete inspection has been made of the upstream face, which has been painted at regular intervals when the water level permitted. The upstream face is in very excellent condition, although there is some pitting, as would naturally be expected from maintaining water at low temperature containing much dissolved air. I would say from the appearance of the front that the steel lining has a life of four times the present period of its existence.
>
> We have been in doubt as to the condition of the back side next to the rockfill. Recently we had occasion for an excavation in the middle back of the steel lining for a depth of about 15 ft. The back side of the steel, while rusty, showed no appreciable deterioration whatever. The state engineer has inspected the reservoir site and expressed himself as quite surprised at the small amount of deterioration.

Here is a steel-faced dam, built 29 years ago, which is in excellent condition, with a steel lining good for four times its present existence. It may be open to question whether a concrete facing would have been any more, if equally, reliable and satisfactory.

New York, N. Y.,
Aug. 3, 1932.

J. R. WEMLINGER.

Causes and Remedies of the Depression

Sir—In reading the proposals to relieve the depression in the United States by the construction of public works, which are contained in your editorials and in the letter written by the American Society of Civil Engineers to the President, I have been surprised by the absence of any explanation as to what are the fundamental causes of the depression. You speak so confidently of a public-works program being an effective remedy, of its countering the effects which these causes, whatever they are, have created, that I presume you are satisfied that you know what the causes are. Otherwise, if the proposed remedy bears no relation to them, it may prove only a palliative.

If you desire to rouse the enthusiasm of the general public for your scheme, would it not be well to demonstrate to them the fundamental causes of the depression and then show how your proposed remedy will remove these causes?

Kilmacolm, Scotland. J. V. NIMMO.

EDITOR'S NOTE—Were the causes of the depression clearly known, corrections could perhaps be applied. But so long as the ultimate causes remain unknown we have to deal with the effects of the derangement of the economic machine. Failure in the mechanism for distributing the country's production and utilizing its available productive capacity to supply the nation's wants has caused vast hardship and suffering. To relieve it, two methods have been proposed: on the one hand, charity; on the other hand, provision of work and earning power in place of that lost through industrial and commercial unemployment. We think that the choice is obvious.

Engineering News-Record

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Twofold Aid to Housing

HOUSING development received twofold aid during recent weeks, through approval of the relief act and the home-loan bank act. Both laws have so extraordinary a range of influence that their ultimate effect cannot yet be forecast. It seems certain, however, that they will revolutionize housing activities, for they furnish ready and safe financing for a type of construction that is sorely needed. The housing clause of the relief act, permitting loans to limited-dividend corporations, is certain to give a stimulus to mass housing that will long survive the life of the measure itself. As yet, only one or two states have provided facilities and the necessary regulation for limited-dividend housing development, so that if the new law did nothing more than lead other states to similar action it would be of great value. But it will also stimulate the development of better planning, technology and management of such projects and will show by practical example how public credit and private initiative can cooperate effectively in this field. The mortgage-discount act affects the soundest and best investment field in the country, yet a field that has perpetuated the medieval condition of exorbitant interest rates, oppressive practices and the absence of a free market. The new mortgage-discount system, introducing into this field the elements of modern credit practices and liquidity, will not alone benefit the home owner but will also relieve our business structure of a crushing burden.

Timber Bridges

AT A TIME when new materials are being proposed on every hand a revival of interest in timber for highway bridges is somewhat unusual. Two related chapters in the history of American bridge building might be titled "The Rise and Fall of the Use of Timber" and "The Introduction of New Materials." For, with the invention and development of steel and concrete, timber's once dominant position was lost. It became and has since remained a bridge material of second choice, with all the neglect that that position implies. In actual volume the use of wood in bridge building has greatly increased since the days of the hewn timber structures. But design has advanced only in rare instances. The covered bridges, which are now regarded with so much sentiment, might also be accorded some honor as representing the acme of timber-bridge design. In recent years parkway and scenic-road designers have found in timber-bridge railings a means of harmonizing their structures with the natural surroundings. In Oregon the state highway department is subjecting the timber bridge to a thorough re-examination in the light of present-day architectural demands and design economics. These developments augur much, for secondary-road construction is in need of a low-cost bridge of pleasing appearance and sturdy construction. The long service record of many early American timber bridges suggests that a satisfactory solution may lie in a rejuvenation of this type of structure. Granted a reasonable degree of fire resistance, a carefully designed timber bridge is well worth considering for many locations.

Half-Built Roads

A CONCRETE or other hard-surfaced highway without firm safe shoulders is but a half-built road. No highway department would think of building a bridge without adequate curb or guard-rail protection for the occasional car that veers slightly from its narrow path; yet the soft or rutty shoulders of many first-class roads are quite as dangerous as a bridge lacking curb and rail. Such shoulders threaten to hurl a car and its occupants to destruction once that car slips off the paved slab. Progressive highway officials are insisting on safe shoulders for their roads, but many others seem to be putting all available funds into slab mileage, ignoring the ever-present hazard of unfinished shoulders. No amount of maintenance will keep a soft shoulder in a safe condition. Adequate shoulder protection must be built into the highway, and every accident due to poor shoulders is an indictment against the roadbuilders. It is time to finish our half-built roads.

A Program Problem

THE DECISION to hold in 1933 a joint construction exhibition, with concurrent conventions of a dozen technical associations, instead of the individual road show and convention of the American Road Builders' Association, opens a difficult question of program management. In a depression year both exhibitor and visitor will appreciate the opportunity to combine in one railway fare and a single attendance the several association meetings in which they desire to take part. But quite as certainly their final approval of the arrangement will rest on the selection of papers and the timing of programs. It is as easy for the group meetings to be an annoying and confusing chaos as to be a helpful recreational and educational experience. The program committee can make the concurrent conventions notable among engineering congresses by devising a well-coordinated program and making attendance on any part quick and easy, or it can make the occasion a warning example of what to avoid.

Sublimating Team Haulage

TRACTOR-TRAILER train haulage as described in this issue, for moving earth into the Mississippi levees, is an advance in equipment service that merits greater acknowledgment than it has received. One reason that it has lacked full appreciation is that it is regarded as an evolution from team haulage and thus partakes of an out-dated transportation practice. It needs to be remembered, however, that antiquated as the cart and horse, or even the four-up team and dump wagon, may now be considered, they possessed a greater universality of application than any other transportation device employed by the constructor. The tractor-trailer unit partakes of this advantage in very large measure and adds to it capacity, speed and continuity of operation greatly exceeding those of the old animal-hauled wagon. With tractor and trailer both mounted on crawlers, the

new unit is an embankment-compacting device superior even to the tamping hoofs of horses and mules. With all of our great power earth-moving machinery looming in superior magnitude, the crawler tractor and trailer occupies a place no whit inferior in practical usefulness to the earth mover. Mechanically, its improvement has been equally as advanced.

Limits on Highway Use

STATE HIGHWAY departments, in the future, are to have more say than they have had in the past as to how and by whom their main trunk roads are used. This conclusion results from a study of recent court decisions in widely separated cases relating to highway regulation.

In a number of recent instances states have passed new laws extending the control of their regulatory commissions over motor-vehicle operations. These laws vary in character; some set up load and size limitations, others require applications for permits or licenses, the carrying of public liability insurance, filing of operating statistics or payment of a ton-mile tax. Generally these newer regulations have infringed what the bus and truck interests, especially those that are not "common carriers," consider to be their constitutional rights. As a consequence, suits to invalidate the laws have been carried to the courts, in two cases to the United States Supreme Court. With minor exceptions the laws have been upheld.

Details of the decisions need not be gone into here. The major ones have been noted in our news pages (*ENR*, June 2, p. 802; June 9, p. 839; June 16, p. 870). The significant thing about them is that they all emphasize the right of states to determine how the highways they build shall be used.

In Kansas a baking company that uses its own trucks to deliver its products throughout Kansas and adjoining states objected to the requirement that it pay a ton-mile tax, obtain a license and file liability insurance, and carried its suit to the U. S. Supreme Court. The court's pronouncement approving of this form of regulation was clear and already has been used in lower court decisions sustaining like state laws. It said: "Requirements of this sort are clearly within the authority of the state which may demand compensation for the special facilities it has provided and regulate the use of its highways to promote public safety. Reasonable regulations to that end are valid as to intrastate traffic and, where there is no discrimination against the interstate commerce which may be affected, do not impose an unconstitutional burden upon that commerce."

Similarly, the same court upheld the Texas law limiting width, height, length, container loads and loads per inch width of tires; and in Ohio the state supreme court has upheld the state public utility commission in refusing to permit an interstate trucking company to operate over a main highway and requiring it to use a less-congested route, on the ground that the highway is already badly congested. In the Texas case the court said: "Limitations of size and weight are subjects manifestly within the broad range of legislative discretion. We do not find the provisions fixing the limit of length for individual motor vehicles and for a combination of such vehicles to be open to objection. If the state saw fit in this way to discourage the use of such trains or combinations on its highways, we know of no constitutional reason why it should not do so."

Thus there is being laid down the foundation of a system of regulation of highway use that will check the present tendency to transfer heavier and larger loads to the public highways, often to the destruction of older pavements and generally at increasing risk to the other highway users, all without commensurate return to the state for the private gain obtained by such use of its highways. States, generally, have been prevented from checking this and similar abuses by the protest that they were interfering with interstate commerce or were infringing upon the constitutional rights of the individual. But that method no longer is effective. The courts now recognize that it can be carried to unjustifiable extremes. Henceforth the states can, by setting up reasonable limitations, determine how and by whom the highways that they have built at great cost shall be used. This right of the state to regulate use of its highways is declared superior to the right of the individual to use them as long as its exercise results in no discrimination between individuals and does not restrict interstate commerce unduly. So long as the states keep such regulations within reasonable bounds and maintain sufficient uniformity to avoid serious embarrassment to operators from outside the state they may expect to keep much of this control in their own hand. Unreasonable and conflicting requirements will force the federal government to take control.

Loan Board Hampered

MORE THAN two hundred applications for loans from the Reconstruction Finance Corporation for self-liquidating projects, as authorized by the Emergency Relief Act, are before the engineering board recently named to aid the R.F.C. in passing upon such projects. While it is gratifying that so many individuals and communities are waking up to the possibilities of the relief act, the flood of applications loads the engineering board with so much work right at the start of its operations as to make delay inevitable. Out of the many applications before it the board has sifted a few that appear to be most promising and has undertaken to give early action upon them. But its preliminary inspection of other applications indicates that most of them either are lacking in essential information or show a woeful lack of understanding of the relief act on the part of those who prepared them.

The board has faced this situation with a determination not to let it interfere greatly with efficient handling of properly prepared applications. Defective applications will be turned back accompanied by a circular from the board indicating what information is required to make an application acceptable to the board. The board takes the position that it cannot undertake to develop lacking information on its own initiative; to do so would needlessly hamper its operations. Here is a splendid opportunity for engineers to aid in getting relief-work projects under way. The information needed by the board is essentially engineering in character. The engineers who assist in the preparation of applications should see that it is *all* given. Or if they have not been called in heretofore—as appears to be the case in many instances—they should make every effort to see that they *are* consulted in the preparation or revision of applications. While the board is still engaged in organizing its forces for quick and efficient operation it should not be burdened with the review of ill-conceived or poorly prepared applications.

NEWS OF THE WEEK

Engineering Board for R.F.C. Loans Makes First Report

THE FIRST report of the engineering advisory board of the Reconstruction Finance Corporation making definite recommendations on some of the 200 odd loan applications before it has been submitted to the directors of the corporation and will be acted upon by them on Aug. 25. It is expected that information as to their action will be available soon thereafter as the directors have announced a more liberal publicity policy, especially as to self-liquidating projects.

When the engineering board took up pending applications two weeks ago, no single application was accompanied by enough supporting data to make a decision. Since that time sufficient data have been secured to justify the board in making several recommendations. Every effort is being made now to get complete information from other applicants.

In each case the board must determine if the project comes within the scope of the law. It must determine if it is feasible from an engineering standpoint and it must have enough information to judge whether or not it will earn a profit. In this latter connection consideration must be given to competing projects. Many of the applications that have been received have aroused strong opposition from the interests conducting projects that would be hurt by the new work.

No application has been received as yet for the 38th St. vehicle tunnel at New York. Apparently difficulty is being experienced in securing the information which must be gathered before the board can act intelligently. It is stated that the effect of this improvement on the George Washington bridge and on the proposed 57th Street structure will have to be considered in acting upon the proposed tunnel.

Changes Made in School of Engineering at Yale and Union

Important changes have been made in the set up of the engineering schools at Yale University and at Union College. At Yale University the teaching of engineering has been carried on heretofore in a division of engineering of the Sheffield Scientific School. Under the net set up engineering will be taught by an engineering faculty in a school with the title of the Yale School of Engineering. This school will include civil engineering, including drawing, chemical, electrical and mechanical engineering, also metallurgy and engineering mechanics. The relation of students of the School of Engineering to all social and extra curricula activities will remain as at present.

At Union College the separate departments of civil, electrical and mechanical engineering are to be coordinated into one department of engineering under the direction of a dean of engineering. Dr. Ernst J. Berg, consulting engineer to the General Electric Co. will occupy the position of dean of engineering. Under the revised curricula the department will offer a fundamental course in engineering with optional courses giving civil engineers special training in building construction and sanitary engineering.

Only 80 students will be admitted annually to the freshman course in engineering.

Lambeth Bridge in London Open

The new Lambeth Bridge across the Thames River in London was opened to traffic recently. The new bridge consists of five steel arch spans, the maximum having a length of 165 ft. (*ENR* March 31, 1932, page 480). It replaces the largest wire-rope suspension bridge in England, built in 1862 and since 1910 used only for foot passengers.

Efforts to Prevent Construction of Golden Gate Bridge End

Efforts to prevent the construction of Golden Gate Bridge will be discontinued, according to an announcement by the Southern Pacific-Golden Gate Ferries, Ltd., that it will not contribute to an appeal from the decision of Federal Judge Kerrigan sustaining the validity of the bridge district and its power of taxation. A similar announcement has been made by the Southern Pacific Company, the largest stockholder of the ferry company.

As no appeal is to be taken from Judge Kerrigan's decision, the bridge district is now in a position to go ahead with financing the project. The present plan is to apply to the Reconstruction Finance Corporation for a loan for the bridge.

Optional contracts for the major construction features of the bridge were let in July, 1931. They are held up pending financing.

R.F.C. Activity Centers on Toll Works As Loan Applications Increase

DIRECTORS of the Reconstruction Finance Corp. and members of its engineering advisory board are reported to be working overtime in an effort to extend loans on self-liquidating projects.

A set of regulations regarding requirements for loan applications is being drafted by the engineering board. It has been completed in tentative form and should be available for publication in the immediate future.

No information has been given out by the federal authorities regarding the applications that have been filed but from local sources of information the following actions have been noted in addition to those previously reported in these pages.

Special legislation in Indiana

On Aug. 17 Governor Leslie of Indiana signed a bill which authorizes cities and towns to put their sewage treatment plants on a service-charge basis. Under the new law cities can issue bonds, bearing not more than 6 per cent interest, to build such a plant. The bonds can be retired and the plant operated entirely from revenues derived from users of the sewerage system, who would be charged upon a water consumption basis. The bill also provides, however, that where the proposed plant would cost more than 1 per cent of the assessed valuation of the city, a referendum election must be held on the question of construction. Construction financed under the new law will become eligible for loans from the R.F.C. if the other eligibility requirements are met.

Detroit, Mich., is considering making application for a loan to finance a refuse incinerator plant for the department of public works. The project is estimated to involve an expenditure of $1,000,000. Negotiations are being carried out with the local office of the R.F.C.

Ohio cities plan applications

An application to the R.F.C. for a loan of $600,000 has been made by Dayton, Ohio. The purpose of the loan is to finance street and sewer improvements and to complete the city's share of the Union Depot project, a part of the railroad grade crossing elimination program.

The city council of Coal Grove, Ohio, is preparing to apply for a loan of $45,000 for the purpose of building a water supply system. The plans provide for the purchase of the water from either Ironton, Ohio, or Ashland, Ky. Pine Bluff, Ark., contemplates asking a loan of $125,000 for the purpose of constructing a new sewage treatment plant and repairing and extending the sewer system.

Funds may be sought from the R.F.C. to aid in eliminating slum areas of Cleveland. After two months of intensive study the city council's committee on housing has recommended that necessary state legislation looking toward the acquisition of federal funds be included in the business to be transacted by special session of the legislature to be held in September. Both state and municipal legislation is required to permit formation of limited dividend corporations, to allow such corporations to exercise the right of eminent domain, to regulate rents and management and to make available the funds offered by the R.F.C.

A special committee of the St. Louis, Mo., Chamber of Commerce has suggested a list of public improvements for which the city should apply for R.F.C. credit. The list includes an additional cast-iron water line from Stacy Park reservoir t[illegible]

the southwestern section of the city and various water main extensions, of $2,500,000; additional approaches to the municipal bridge, $1,500,000; construction of parking space for hire beneath the Memorial plaza, $3,000,000; and the construction of a subway in downtown St. Louis.

Because of objections brought by Mayor Moore of Philadelphia, the Delaware River Joint Commission decided to postpone for a month its application for a loan of $39,000,000. The purpose of the proposed loan is to pay back to Philadelphia and New Jersey and Pennsylvania their investments in the bridge, totaling about $31,000,000, and for financing a new high-speed transit line across the bridge from Philadelphia to Camden. Mayor Moore has indicated that he will not approve the application until the city council has had an opportunity to express an opinion.

Commissions to make studies

An engineering commission is to be appointed by the city commission of Birmingham, Ala., to prepare plans and data on which a loan will be sought for the construction of an industrial water supply system for the city. The project will incur the laying of about 20 miles of mains. Former surveys of the cost of bringing the water in from the Warrior River, to be impounded in a central reservoir in the city, have shown that the cost will be between $1,000,000 and $2,000,000.

In Arkansas Governor Parnall has appointed a board to make a survey of the state to determine the number of self-liquidating projects that can be financed under the provisions of the relief act. The committee consists of H. S. Peck, city engineer, Fort Smith; W. L. Winters, consulting engineer, Fort Smith; C. L. Wright, city engineer, Pine Bluff; and J. W. Dawson, consulting engineer, Texarkana; A. F. Annen, city engineer, Hot Springs; and E. M. Ratliff, superintendent of waterworks at Fayetteville.

The Colorado Engineering Council has named engineers to sit with a committee of industrial and business leaders to map out a program of projects for which it may be possible to obtain R.F.C. loans. The engineers on the committee are Herbert F. Crocker, president, American Society of Civil Engineers, R. C. Gowdy, chief engineer, Colorado & Southern Railroad, William B. Freeman, engineer, Lock Joint Pipe Co., and C. M. Lightburn, secretary of the council.

Formal applications from Oklahoma

Oklahoma City, Okla., filed formal application on Aug. 12 with the local representative of the R.F.C. for a loan of $350,000 to be used for water main extensions. The city is also giving serious consideration to applying for a loan of $500,000 for sanitary sewer and storm sewer main construction.

Discussion is being given to R.F.C. financing to the extent of $200,000 for waterworks improvements in Hobart, Okla. Ponca City is considering waterworks extensions in the amount of $300,000, and Heavener, waterworks improvements in the amount of $30,000, both to be financed by the R.F.C.

It has been learned that immediately following the passage of the R.F.C. bill in July, the Tarrant County (Texas) Water Improvement District No. 1 made application for a loan of $1,165,000 for levee rebuilding and other reclamation work.

In response to a suggestion from the state board of health a number of Utah municipalities have entered into negotiations looking to application for loans for the construction of improvements to municipal water supply and sewerage systems. The improvements recommended by some 28 cities total $1,318,000 for water supply improvements, much of which involves replacement of wood-stave pipe by metal or concrete. Nine other towns list water system or sewerage construction totaling $395,000.

Verde River Irrigation and Power District, Phoenix, Maricopa Co., Ariz. has applied for a loan of $23,000,000 to start construction work on its project.

Mayor Congleton of Newark, N. J., has written to the R.F.C. asking for a loan of $6,500,000, of which $5,000,000 is for the completion of the City Railway, an underground line for trolley cars from Market St. to the Belleville city line, $1,000,000 for a bridge over the Jersey Central tracks and the balance for dock repair and channel dredging.

State Loans for Town Roads to Be Made in New Hampshire

Loans from a fund of $1,000,000 accumulated by the state highway department of New Hampshire are to be made to the towns for work on secondary roads as a measure of unemployment relief, according to an announcement by Governor Winant. The work will be carried on under the direction of the state highway department, the entire upkeep of the primary and secondary road systems in the state having been taken over by the state recently.

Washington Notes

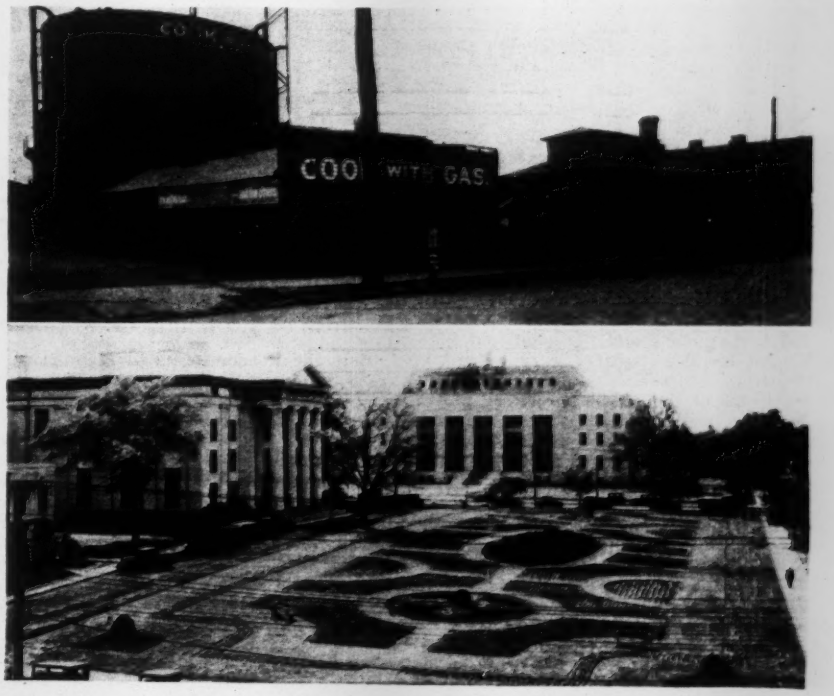
By Paul Wooton
Washington Correspondent

Charges made by Senator Tasker L. Oddie, of Nevada, in connection with work at Hoover Dam are based on misunderstandings, it is believed at the Interior Department. Six Companies, Inc., pays in cash each two weeks and not in script as charged by Senator Oddie. The use of script is confined to advance payment of salaries. In order to facilitate bookkeeping the company in making advances to employees has worked out a script system. This, however, is purely an accommodation to employees which the contractor is not required to extend.

Reports which have been made to Washington show that Six Companies, Inc., will have a loss instead of a profit on its investment in housing and feeding. In that connection it is pointed out that many of the men are married and have their meals at home. They are not required to buy at the company commissary. The stores in Boulder and in Las Vegas offer ample opportunity for purchases under competitive conditions.

No work is being done on a 30-hour basis as charged by Senator Oddie. Because of that provision in the relief act no plans are being made to use the $10,000,000 made available therein for work at Hoover Dam.

The question of the authority of the state of Nevada to collect taxes and enforce its laws in a federal reservation is now being determined in the courts.



GAS HOUSE DISTRICT MADE MUNICIPAL CENTER

A municipal center of striking appearance has been created in Jackson, Miss., through clearing out an obsolete gas plant and dilapidated municipal buildings in a square adjoining the city's 100-yr.-old city hall of classic design. The Hinds County court house at the far end of the square is of modern construction designed to harmonize with the city hall. The work was carried out under the direction of Walter A. Scott, mayor, and J. J. Halbert, city engineer of Jackson.

International Road Congress Preliminary Program Drafted

A draft of the agenda for the seventh International Road Congress to be held in Munich in September has been received by the Bureau of Foreign & Domestic Commerce. The program is set up under two headings, construction and maintenance, and traffic operation and administrations. Under construction and maintenance the questions are:

1. Progress made since the Congress of Washington in the use of cement for the construction of roads.

2. Progress made in the preparation and use for the construction and maintenance of roads: (a) of tar; (b) of bituminous products; (c) of mixtures.

3. Methods available for the construction and maintenance as economically as possible of road surfaces, either in populated or unpopulated districts. Processes employed, and study of the conditions which make it advisable to use one process or another according to conditions of the soil and of climate.

The traffic operation and administration questions are:

1. The proper means for assuring safety in traffic: (a) in cities; (b) in open country; (c) grade crossings for railroads. Legislation — Rules — Signaling.

2. Study of the relations between vehicle traffic and the surface of the roads from the standpoint of economy of transportation; technical, legislative or regulatory arrangements to prescribe for traffic in order to reduce to the minimum damages of all kinds caused by traffic, such as vibration and noise.

3. Coordination and cooperation of transport by highway, rail, water, and air. Results obtainable from the standpoint of economy, rapidity, and comfort. Technical, legislative or regulatory measures which should be given consideration.

Flood Control and Harbor Money Not Available Before Winter

Washington Correspondence

No determination has been reached as yet by the Secretary of War as to whether or not the additional $30,000,000 for river and harbor work and the additional $15,500,000 for flood control work carried in the relief act will be asked. Under the provisions of the act the Secretary of the Treasury must certify that these sums are available or can be borrowed on reasonable terms. At present so little is known as to the volume of tax receipts that may be expected that the Secretary of the Treasury has no way of ascertaining whether the necessary money will be available. No reliable estimates can be made until late fall and a determination as to the availability of the funds is not expected until winter.

The Secretary of War anticipates no great difficulty in meeting the requirements of the law with regard to the 30-hour limitation on the working period. This condition is imposed by the statute only in so far as it may be practicable. For that reason it is expected that work far removed from cities and towns, where it is necessary to establish camps, will be conducted on the old basis, while work near centers of population can be conducted with two 5-hour shifts or under some other arrangement which will comply with that feature of the law. This is the practice being followed by the Bureau of Public Roads. It is not regarded as practicable to double the size of the camps in order to spread work. Some of the road contractors are planning to work two 6-hour shifts five days a week. This will be reduced to one 6-hour shift in the winter when the days are shorter.

Major General Lytle Brown, the Chief of Engineers, states that the $15,500,000 for flood control work can be used to advantage.

Bridge Approaches to Be Rebuilt in Timber to Cut Cost

Reconstruction of the approaches to Ballard Bridge in Seattle in treated timber instead of reinforced concrete is proposed in a new bond issue to be submitted to the voters in the November election. A proposed bond issue of $1,800,000 for widening the bridge and rebuilding the approaches with concrete and steel was rejected by the voters at the March city election. Under the proposed plan the approaches will be rebuilt at a cost of $350,000 but widening of the bridge will not be undertaken at the present.

Contractors License Law Planned for Iowa

A license law for contractors in the state of Iowa is being drawn up by a committee of the central branch of the Associated General Contractors under the chairmanship of W. A. Klinger, of Sioux City. The committee has been carrying on an investigation of the license laws now in effect in other states, and gathering the opinions of contractors, public officials and organizations in those states about their laws. The committee is now preparing to work on the data collected by this investigation. Suggestions advanced at a preliminary meeting of the committee indicate that a number of entirely new provisions may be incorporated in the proposed law for Iowa.

Railway Conventions Canceled Because of Economic Conditions

Both the Roadmasters and Maintenance-of-Way Association and the American Railway Bridge and Building Association have decided to cancel their annual conventions for 1932. This will be the second year that these conventions have not been held, but the American Railway Association urged this action on the ground that business activity is at a lower level than it was in 1931. The 1931 committees of the Bridge and Building association prepared their reports as usual, and it was intended to have them presented at the 1932 meeting. The committees of the Roadmasters association did not prepare reports, but were continued in order to report in 1932 and are now again continued. However, two new committees have been appointed to report in 1933: "Handling and Disposition of Used Track Materials," T. A. Blair, division engineer, Santa Fe R.R.; "Time Leaks in Maintenance Work," C. H. R. Howe, cost engineer, Chesapeake & Ohio Ry.

Rates Set for Highway Work Under the Relief Act

Wage rates and hours of work on highway contracts in Missouri for all work under the provisions of the Emergency Relief and Construction Act have been set by T. H. Cutler, chief engineer of the highway department. A minimum wage of 35c. an hour for unskilled and 50c. for skilled labor is to be paid. The maximum week of 30 hours, as required by the act, is specified. Similar determinations for other states were noted in *ENR* Aug. 18, p. 208.

Considerable hand labor is required to be substituted for machine labor under the act. In Missouri it is estimated that this change will increase the number of men on highway construction and maintenance from 9,000 to 21,000.

Survey of Tides and Currents Being Made at New York

A new tide and current survey of New York Harbor is being carried out by engineers of the Coast and Geodetic Survey in cooperation with the army engineers of the district. In predetermined planes across the channel at numerous points throughout the harbor continuous observations are being taken on the strength and direction of the current for correlation with tidal observations taken at the shore along the same lines. The new survey is being made because of changes made in the channels since the last survey, nearly 16,000,000 cu.yd. of material having been moved since the survey of 1922.

Due to the complicated arrangement of channels at New York Harbor unusal conditions are set up by variations in tide level. Frequently, the actual height of the surface of the water at Governors Island is about 5 ft. lower than at Willets Point, only 15 miles away. This slope gives rise to the excessive current through the East River and Hell Gate.

Missouri to Investigate Water Treatment in Three Towns

The Missouri Public Service Commission has ordered an investigation into the methods of treating the water supplied by the St. Louis County Water Co. to Webster Groves, Mo.; by the Missouri Power & Light Co. to Mexico, Mo.; and by the Warrensburg & Pertle Springs Water Co. to Warrensburg, Mo. The state board of health has recommended that a purification plant be installed at Warrensburg and that filtration plants be built at Mexico and Webster Groves.

Waterway Bonds to Be Sold

To raise additional funds for the Illinois waterways the state treasurer, on Aug. 25, will take bids for $1,000,000 in 4 per cent waterway bonds. The issue is part of a total of $20,000,000 authorized a number of years ago, of which $18,000,000 have been sold.

The federal government has taken over the work of the waterway itself and the state money, now being raised, is to be used for the construction of bridges across the new channel.

Floods Wash Out New Dam

A rainfall, stated to be three inches in three hours, on August 14, in Northeastern Missouri, washed out a 30-ft. section of the new dam for the water supply reservoir of the town of Memphis, Mo. The dam was completed last spring. It is 300 ft. long and 32 ft. high.

New Bids Called for High Dam for Los Angeles Flood Control

New bids for the construction of San Gabriel dam No. 1 of the Los Angeles County Flood Control District have been asked for. They will be opened on Sept. 6. The dam is to be a rock-fill structure 375 ft. high. Its estimated cost is $9,743,000.

On Aug. 8 the district rejected the bid of Constructors, Inc., the only bid received on the previous call. That company bid $11,270,000 for the construction of the dam with a concrete face placed by the gunite process or $11,316,000 for a dam with the water face of poured concrete. Under the new call for bids a single bid for the entire job will be accepted or separate bids for excavation, tunnels, rock fill, concrete, grouting, and placing steel.

Progress Made on Waterway Along the Gulf Coast

Good progress has been made in constructing the intercoastal canal that is to run between the Mississippi River and the mouth of the Rio Grande, according to an official report on the project which was made recently by Major Milo P. Fox, U. S. District Engineer, Galveston, Texas.

From the Sabine River to the head of the Port Arthur canal, a distance of 23 miles, the intracoastal waterway traffic will follow existing improved channels of the Sabine-Neches waterway, Mr. Fox said. There is at present no inland waterway connection from the head of the Port Arthur canal to Galveston Bay, a distance of 66 miles. Contracts have been let for dredging this reach except for two lengths, each about one mile long, one at the location of a proposed swing highway bridge on the Port Arthur-Sabine highway and the other at the proposed location of a bascule railroad bridge and a swing highway bridge near High Island. Each bridge will have a horizontal clearance of 100 ft. Preliminary plans are under way for the construction of all the bridges. Dredging being done under existing contracts is about 29 per cent completed. This section of the waterway should be completed by June, 1933.

The Galveston Bay-Freeport section of the waterway is 42.5 miles long. All necessary field work has been completed and maps have been made covering the entire waterway. Local interests have been requested to secure spoil disposal areas and rights of way. Dredging in this section of the waterway may be advertised during the fiscal year 1933.

The Freeport-Corpus Christi section is about 186.5 miles long, of which a length of about 50 miles will require no dredging. All necessary field work has been completed and maps have been prepared covering the entire proposed waterway. If required local cooperation is met, dredging in this setcion of the waterway may be advertised during the fiscal year 1934.

Brief News

Extension of the Timiskaming and Northern Ontario Railway to its terminal at the new port of Moosenee on James Bay was formally opened on July 15.

Peru, Ind., dedicated its newly completed 3-m.g.d. water filtration plant on July 31. The plant is designed to remove the iron from the present well supply or to purify water from the Wabash River.

Construction of an International Bridge across the Rainy River at Baudette, Minn., has been begun. The bridge will serve as a link in the new highway to furnish a direct route from the southern part of the state to the city of Winnipeg.

Gas-Tax Receipts in some states have increased this year despite a falling off in motor vehicle license fees. Missouri reports $3,509,000 this year as against $3,462,000 for the first five months last year and Maine reports a similar condition.

Elimination of Four Grade Crossings in the city of Hartford, Conn., will not be undertaken until July 1933. The public utilities commission of Connecticut has granted the New York, New Haven & Hartford R.R. a stay of its order on account of financial conditions. The commission recommends to the city that it proceed with the acquisition of the private property required. The cost is to be borne jointly by the city and railroad.

A New Highway from Fonthill, Ontario, to Fort Erie, 26 miles, is being built by the Ontario Government, to give an additional outlet for traffic from Toronto and the Hamilton district to the Peace Bridge across the Niagara River at Buffalo. Traffic on the existing highways is badly congested. The new road will cost $500,000, and will take three months to build, and will give employment to about 1,000 men.

A Protest Over the Tentative Valuation proposed for the St. Louis & O'Fallon R.R. and the Manufacturers' R.R. by the Interstate Commerce Commission (*ENR* August 4, 1932, p. 144), has been made to the commission by representatives of the railroads concerned. This protest indicates that the commission's findings will not be accepted by the railroads and as a consequence this now-famous case in public utility valuation will be subject to further airing in the courts.

An Intracoastal Canal from Miami to Florida Bay, Fla., with a width of 75 ft. and a minimum depth of 7 ft. has been approved by the Chief of Engineers in a report to Congress. The cost is estimated at $130,000. Deepening the outer channel at Green Bay, Wis., between Tail Point and Fox River to provide a depth of 22 ft. and widening the Fox River channel through the city of Green Bay. also is recommended. The total cost of this latter work is placed at $734,000. Approval depends on local aid.

Electric Train Service between New York and Philadelphia on the Pennsylvania Railroad will be inaugurated next February. From Philadelphia to Trenton construction work has been completed and suburban electric trains have been operating since July 1, 1930. Work from Trenton to New York is well along toward completion. Two tracks with a platform between them at the lower level of the new 30th Street Station in Philadelphia will be used by this through service, access being obtained through the suburban station on the upper level. The old West Philadelphia Station will be abandoned.

Personal Notes

L. P. Wolff, consulting engineer, St. Paul, has retired from active practice on account of ill health.

M. Perrault, of Sherbrooke, Quebec, is superintendent of construction on the new Prince of Wales College at Charlottetown, P.E.I., for the Stewart Construction Co., Sherbrooke.

Douglas L. Weart, major, Corps of Engineers, U. S. Army, at present stationed at Savannah, Ga., has been appointed assistant to the president of the Mississippi River Commission, Brig. Gen. Harley B. Ferguson at Vicksburg, Miss. He will take over his new duties Oct. 1.

Fred Lavis, consulting engineer, New York, former president of the International Railways of Central America, has gone to the Dominican Republic at the request of the president of the republic to report upon the general land transportation system with special reference to the coordination of rail and highway facilities.

Edward J. Thomas, principal engineer in the office of the president of the Mississippi River Commission, has been retired after 43 years of service with the commission. He is one of the foremost authorities on the hydraulics of the Mississippi River in the country.

Harry Culverhouse, assistant engineer, Jefferson County Commission, Birmingham, Ala., has been named superintendent of roads for the county and the office of county engineer has been abolished. Claude J. Rogers was county engineer.

Francis H. Wisewell has opened an office as a contracting engineer in Rochester, N. Y. He will specialize in the design and construction of elevating and conveying machinery installation and storage structures. Mr. Wisewell formerly was with the United States Gypsum Co.

Obituary

P. H. Weber, retired civil engineer, Canton, Ohio, died there on Aug. 17 after a brief illness. He was 73 years old. Mr. Weber served as city engineer of Canton for eight years.

Albert Owen Rouse, until his retirement on Jan. 1, 1931, one of the civilian engineers of the Corp of Engineers, died at his home in Rock Island, Ill., Aug. 17, aged 66.

W. H. Schuerman, dean of the engineering department of Vanderbilt University for the past 37 years, died on Aug. 11 while swimming near his summer home in Smoky Mountain Park. Dr. Schuerman was a native of Cincinnati and a graduate of the University of Cincinnati in the class of 1881. From 1888 to 1890 he was office engineer on the construction of the waterworks for Covington, Ky., and from 1890

to 1893 he was on irrigation work in Kern County, Calif. The following year he went to Vanderbilt University.

THOMAS M. REED, chief engineer, bureau of engineering, Pittsburgh, Pa., died there on Aug. 23, aged 55 years. Mr. Reed had been head of the bureau since 1926. Previous to that time he was a division engineer in the bureau for 18 years. His previous engineering work had been with the city of Allegheny, Pa.

Engineering Contracts and Capital

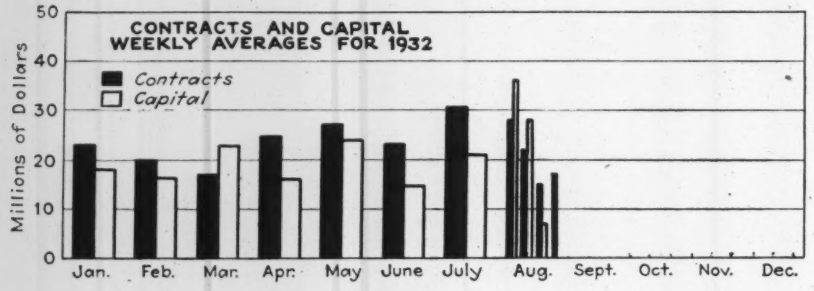
HEAVY ENGINEERING construction contracts reported the past week total $16,733,000, as compared with the previous week's total of $14,751,000 and the August weekly average of $20,351,000. This is the smallest weekly average of any month since last March. Highway lettings for the past week amounted to $8,100,000. Kentucky let contracts for road work aggregating $1,296,000, and Georgia awarded highway contracts totaling $1,978,000. Federal government awards for the week were unusually low, amounting to $2,476,000. Cumulative contracts to date this year total $800,207,000, as compared with a total of $1,788,158,000 for the same period last year.

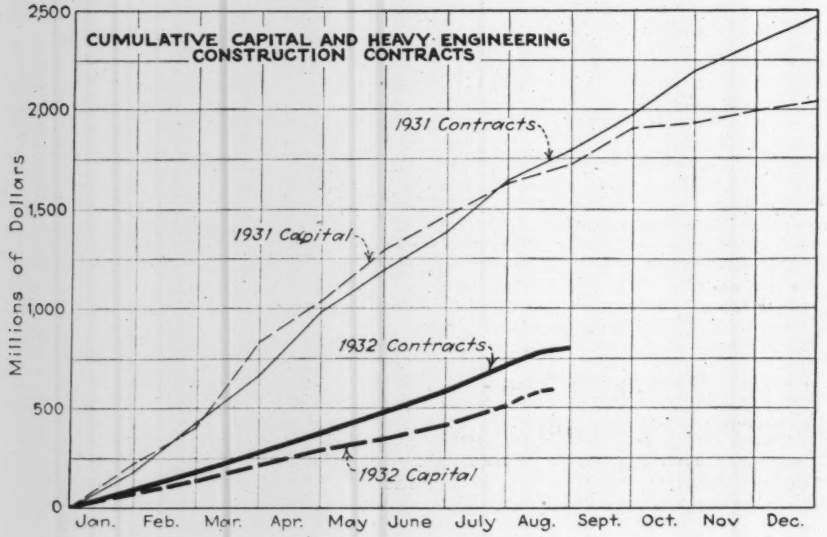
Few new capital issues appeared last week, the total amount being $7,087,000, all public issues. Pittsburgh sold a bond issue of $2,300,000 for public improvements.

Cement Prices Increase in New York—An increase in the price of cement for most points in New York state except New York City has been announced, the increases ranging from 19c. to 34c. per barrel. New York state producers have abolished delivery by trucks and all future quotations will be based on rail delivery. It is reported the change resulted from the unsatisfactory conditions in truck haulage arising from ruinous competition between trucking interests.

Steel Sales Improve—Some improvement has been noted in sales of steel products by jobbers, though mill production has not increased. Production of steel ingots remains about 14 per cent of capacity. In the Youngstown district production schedules for the past week were the highest for the summer, several idle plants resuming operations.

Minimum Wage Set in Wyoming—The Wyoming state highway department has issued rulings to govern working conditions on road work to be done under the emergency federal aid appropriations. A minimum wage of 50c. per hour has been set, skilled labor to receive a minimum of 60c. Working hours will be limited to 30 per week and eight per day for any one workman. Camps are not allowed to charge more than 75c. per day for board.





SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual convention, Washington, D. C., Sept. 26-28.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, White Sulphur Springs, W. Va., Oct. 11-13 (tentative).

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, annual meeting, Toronto, Ont., Canada. Cancelled.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Atlantic City, N. J., Oct. 5-8.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, New Orleans, La., Nov. 14-18.

AMERICAN WELDING SOCIETY, fall meeting, Oct. 3-7, Buffalo, N. Y.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-7. The ASSOCIATION OF ASPHALT PAVING TECHNOLOGISTS will meet in conjunction with the paving conference.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, annual conference, Pittsburgh, Pa., Sept. 29-Oct. 1.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, New York City, Sept. 29-Oct. 1.

NATIONAL SAFETY COUNCIL, annual congress, Washington, D. C., Oct. 3-7.

NEW ENGLAND WATER WORKS ASSOCIATION, annual meeting, Springfield, Mass., September 27-30.

WISCONSIN SECTION, American Water Works Association, Oct. 11 and 12, will hold its eleventh annual meeting at Appleton. L. A. Smith, Madison, is secretary.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly Aug., 1931	Average Aug., 1932	Week Aug. 25, 1932
Federal government	$2,710	$4,175	$2,476
State and municipal	17,904	12,334	11,466
Total public	$20,614	$16,509	$13,942
Total private	16,612	3,842	2,791
Week's total	$37,226	$20,351	$16,733

Cumulative, Jan. 1 to date:
1931 construction $1,788,158
1932 800,207
Decrease, 55 per cent.

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly Aug., 1931	Average July, 1932	Week Aug. 20, 1932
Total private and public	$21,000	$24,000	$7,087

Cumulative, Jan. 1 to date:
1931 new capital $1,694,000
1932 new capital 588,000
Decrease, 65 per cent.

ENR Cost and Volume Index

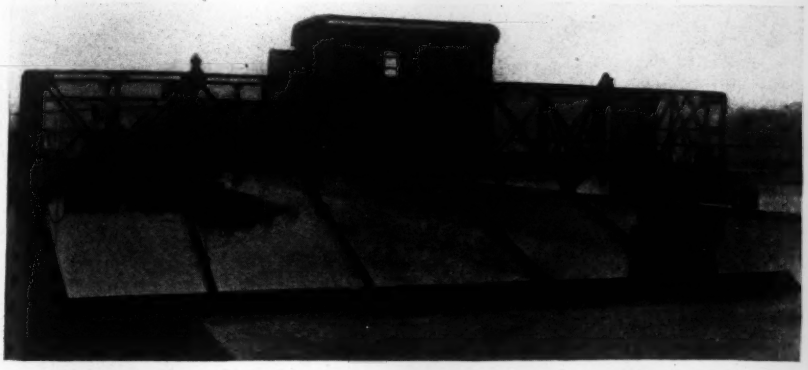
Cost		Volume	
August, 1932	**156.80**	**July, 1932**	**166**
July, 1932	153.36	June, 1932	131
August, 1931	171.38	July, 1931	248
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
		1913 Average	100.00

Construction Equipment and Materials

Sludge Collector and Skimmer for Sewage-Treatment Plants

Patent rights for the sale and construction in the United States of the Mieder collector for the removal of sludge from primary settling tanks in sewage-treatment plants have been acquired by the Link-Belt Co., Chicago, Ill. The machine was developed in Germany.

The Mieder collector consists of a traveling bridge to which is hinged a deep scraper. This scraper moves the sludge on the bottom of the tank toward the influent end, where it is withdrawn. On the return run the scraper is raised to the surface of the liquid in the tank and used for skimming. All the driving machinery is located on the bridge. It is stated that one collector can serve a large plant, being transferred from one tank to another. At Leipzig, Germany, one machine serves four tanks, each about 40 ft. wide and varying in length from 160 to 200 ft.



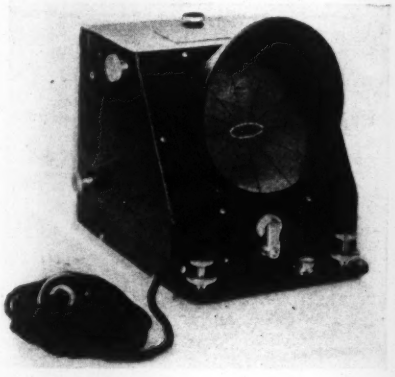
New Link-Belt sludge scraper.

Apparatus Measures Vertical and Horizontal Vibrations

Machine vibration amplitude both vertical and horizontal are visually shown on the new Davey vibrometer of the Electrocon Corp., 6 Varick St., New York, and by use of sensitized paper they may be permanently recorded. The instrument is designed for the use of mechanical engineers in checking the balance of such equipment as motors, turbines and generators and for structural engineers who must design supports for moving machinery. The instrument shown in the accompanying illustration weighs 8 lb., having plan dimensions of 7½x5½ in. and a height of 7 in. When it is laid on the object whose vibrations are to be measured a spot of light traces out the exact path of the vibration, magnified many times, on a ground glass scale 4 in. in diameter.

The instrument works on the principle of the seismograph, the main element being a weight suspended on springs. When the instrument is subjected to vibration, the instrument moves but the weight remains stationary. It is claimed that a novel method of suspension makes possible the use of an unusually light weight and at the same time a low natural frequency of oscillation.

Machine vibration indicated by new instrument.



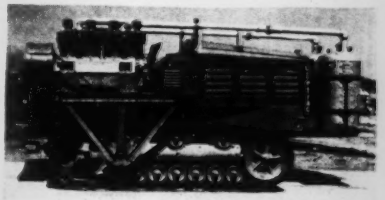
New Equipment in Brief

Stress-Strain Recorder—The Baldwin-Southwark Corp., Philadelphia, Pa., announces the new Southwark-Emery stress-strain recorder. At normal testing speed the recorder, when attached to a material-testing machine, draws an accurate stress-strain diagram. The strain values plotted by the recorder are the averages of two Huggenberger tensometer readings, mounted on two sides of the specimen bar.

Truck Mixer—The new Rex 1½-yd. Moto-Mixer is announced by the Chain Belt Co., Milwaukee, Wis. Its design, construction and general features are patterned closely after the other members of the Rex Moto-Mixer line. The drum has a three-point suspension. In addition, by shortening the diameter of the rear drum track, the entire drum is swung between the body sills to establish a low center of gravity. Mixing water is measured by means of a calibrated overflow pipe, extending into the mixing water compartment. The drum is driven by an independent motor equipped with an electric starter that operates from the truck's battery.

Improved Tractor Mounting for Air Compressor

An improved method of mounting a heavy-duty air compressor on a tractor has been developed by the Cleveland Tractor Co., Cleveland, Ohio, working with the Davey Compressor Co., Kent, Ohio. Two four-cylinder Davey air-cooled compressors, with a combined displacement of 640 cu.ft. per minute, are mounted tandem, and are connected with drive sheaves by independent sets of V-type belts. A 4-in. shaft extends through the tractor, fitting into the truck frame at either side. This serves to carry directly the dead weight of the compressors and to relieve the tractor transmission case of strain caused by the superimposed load. Compressors are built largely of aluminum and weigh 725 lb. each. By putting the weight of the compressors over the tracks and near the seat, the equilibrium of the machine is established.



Davey compressor mounted on Cleveland tractor.

New Publications

Welding Equipment—"Welding Electrodes & Accessories" is the title of a 16-page booklet published by the General Electric Co., Schenectady, N. Y. It contains a description of the characteristics of the various types of electrodes for general and special purposes. It also describes such welding accessories as helmets, shields, glass, electrode holders, cable, reactors, etc.

Small Beams—Jones & Laughlin Steel Corp., Pittsburgh, Pa., has put out a booklet of 24 pages describing the uses of J & L junior beam floors for residences. In addition to giving the geometric and structural characteristics of J & L junior beams, ranging in size from 12 in., 11.8 lb. to 6 in., 4.4 lb., the book describes the uses of these structural elements in residence construction.

Bituminous Paving—"Pre Cote Bitumen & Aggregate" is the title of a booklet recently published by the Pre Cote Corp., Indianapolis, Ind., describing Pre Cote processes, equipment and materials for constructing bituminous pavements. The cold laid mix known as "Pre Cote" is a coarse-graded-aggregate asphaltic concrete. The book contains a discussion of bituminous paving materials and gives illustrations of the uses of the Pre Cote asphaltic emulsion.

Lathes—"Repair Shop Lathes" is the title of a booklet recently put out by the South Bend Lathe Works, South Bend, Ind., describing a new line of low-priced lathes designed for maintenance shops of highway departments, contractors and engineers, and autofleet repair shops. Seven sizes of lathes, from 8 in. to 36 in. swing, are given in various types of motor drive and in countershaft drive. The lathes are of the backgeared, screw-cutting type.

Colloidal Graphite—The Atcheson Oildag Co., Port Huron, Mich., has published a 24-page booklet entitled "Colloidal Graphite" describing the properties, uses and advantages of that material as a lubricant. The lubricating material consists of a selected grade of lubricating oil carrying in suspension a definite amount of colloidalized graphite. The colloidalizing process consists of reducing the size of purified graphite particles to the point where they are visible only by reflection in the ultramicroscope. The graphite particles then are non-settling and are able to pass through fine openings without clogging.

Current Construction Unit Prices

Creosoted Timber Pile Wharf, New Orleans

EXTENSION of the Charbonnet St. wharf, New Orleans, for which contract was let in June, calls for 690 creosoted timber piles 60 to 90 ft. long, and 282,000 f.b.m. of timber bracing, caps and stringers, treated with Wolman salts or zinc meta arsenate. The existing wharf, 138 ft. wide, is being extended 300 ft. Piles are spaced 10 ft. c. to c. transversely and 8 ft. c. to c. longitudinally. Piles are protected at cut-off by asphalt-saturated canvas or galvanized iron sheet, depending upon location. Caps are laminated construction of four 3x12-in. planks. Stringers are 3x12 in. spaced 2 ft. c. to c. The deck is a 4-in. reinforced concrete slab. A concrete firewall is provided near the existing wharf. A timber fire stop of two layers of 2x10-in. planking will be built into the extension about the mid-point. Contract was let by the Board of Commissioners of the Port of New Orleans to A. P. Boh & Co., New Orleans, for $59,703.

Following are contract unit prices of principle items:

Item	Quantity	Unit Price
PILING: (all creosoted)		
60 ft. long, each	15	$29.00
65 ft. long, each	6	31.00
70 ft. long, each	85	33.00
75 ft. long, each	126	38.00
80 ft. long, each	161	40.00
85 ft. long, each	151	46.00
90 ft. long, each	146	53.00
Cutting off and creosoting tops, each	690	.50
Canvas protection of tops	586	1.00
Sheet metal protection	35	1.00
Bolting fender piles	35	3.60
TIMBER CONSTRUCTION:		
Pile bracing, M.b.m.	108	63.00
Laminated caps, M.b.m.	67	68.00
Wharf stringers, M.b.m.	88	64.00
Mooring bitt timbers, M.b.m.	2	84.00
Timber bulkhead, M.b.m.	11	73.00
New wharf logs, M.b.m.	6	84.00
CONCRETE CONSTRUCTION:		
Deck slab, 4-in., sq.yd.	4,865	1.20
Slab to fill, sq.yd.	333	2.00
Concrete fire wall, cu.yd.	250	9.50
Curb angles, 2x2x$\frac{1}{4}$ in., ft.	4,120	.22
Curb angles, 3$\frac{1}{2}$x3$\frac{1}{2}$x$\frac{1}{4}$ in., ft.	520	.50

Lake Okeechobee Channel and Levee

ANOTHER step in the flood control and navigation program for Lake Okeechobee, Florida, was started in July with the award of a contract for 65,000 lin.ft. of levee and navigation channel along the south and east shores of the lake. The work involves the removal from the navigation channel and placing in levee about 4,860,000 cu.yd. of material, and the placing of 55,000 cu.yd. of riprap along the berm. Eleven bids were received, ranging in total amount from $649,432 to $1,352,500. Contract was awarded to the low bidder, Canal Dredging Co., Memphis. The work is under the supervision of the Corps of Engineers, though the local districts are sharing in the cost. Major B. C. Bunn is district engineer in charge. Following is an abstract of all bids:

Bidder	Excavating Channel and Building Levee. 4,860,000 Cu.Yd. Unit Price	Furnish and Place Riprap 55,000 Cu.Yd. Unit Price	Total Bid
Canal Dredging Co., Memphis (contract)	$0.1162	$1.54	$649,432
Spadro Contracting Co. and Geo. Colon & Co., New York	.145	.72	74,500
The Arundel Corp., Baltimore	.137	1.80	764,820
Trinity Farms Construction Co., Dallas	.1451	1.70	798,686
Van Gordon Construct. Co., Jacksonville, Fla.	.16	1.75	873,850
L. A. Wilson & Co., Ottawa, Ill.	.1713	1.00	887,518
McWilliams Dredging Co., New Orleans	.1525	3.00	906,150
P. J. O'Brien, Jacksonville	.156	3.80	967,160
Wilbanks & Pierce, Inc., New Madrid, Ind.	.174	2.40	997,640
Siems-Helmers, Inc., St. Paul	.184	4.00	1,114,240
R. C. Huffman Const. Co., Cleveland	.25	2.50	1,352,500

Gravel Surfacing and Oil Mat, Idaho

BIDS received by the Idaho Department of Public Works in June for the construction of 26.086 miles of crushed gravel surfacing and plant-mix oil mat on the Idaho-Montana road in Bonneville and Jefferson counties ranged from $86,513 to $121,149. Eight bids were submitted, all but one being below the engineer's estimate of $111,233. Contract was let to Olaf Nelson, Logan, Utah, the low bidder. G. E. McKelvey is Commissioner of Public Works.

Following are unit bid prices of the three low bidders and the engineer's estimate. (A) Olaf Nelson, Logan, Utah, contract; (B) Morrison-Knudsen Co., Boise, Idaho; (C) Hunt & Shannon, Butte, Mont.; (D) Engineer's estimate.

Item	Quantity	Unit Bid Prices (A)	(B)	(C)	(D)
Excavation, unclassified	10,900	$0.18	$0.16	$0.16	$0.30
Overhaul, sta. yd.	3,600	.03	.01	.05	.03
Haul on excav., m.yd.	1,250	.15	.10	.10	.15
Subbase gravel, cu.yd.	20,000	.60	.77	.85	.80
Crushed gravel, cu.yd.	12,600	.78	1.03	.90	1.00
Binder, cu.yd.	3,720	.15	.20	.15	.20
Haul on binder, m.yd.	10,000	.12	.10	.13	.12
Sprinkling water, m.g.	554	1.00	1.50	1.50	3.00
Rolling, days	30	10.00	15.00	10.00	15.00
Prime coat, bbl.	1,160	.60	.90	1.00	.60
Bituminous oil mat, tons	38,000	1.45	1.30	1.42	1.80
Maintenance material, cu.yd.	5,000	.40	.50	.45	.50
Haul on maintenance mat., m. yd.	27,000	.07	.10	.08	.12
Total		$86,513	$89,114	$93,086	$111,233
Wages per day or hour		3.20	.40	3.00	-

Rock Dredging in East River

CONTRACT for removal of 49,980 cu.yd. of rock and 27,850 cu.yd. of other material from the channel in Hell Gate, East River, New York City, is awarded in May by the U. S. Engineer Office to the Great Lakes Dredge & Dock Co., New York. Hell Gate carries heavy traffic and conditions present a decided menace to safe navigation. This factor, with ever-present possibilities of collisions in the swift tidal flows, adds to the difficulties of the work and increases the cost. Disposal haul averages $\frac{3}{4}$ mile.

The contract was awarded to the lowest of six bidders. Unit contract prices are as follows: Rock, 49,980 cu.yd., place measurement, $4.55 per cu.yd., total $227,409. Other material, 27,850 cu.yd., place measurement, $1.00 per cu.yd., total $27,850. Total contract $255,259.

Retaining Wall, Illinois Waterway

CONTRACT for the construction of concrete retaining walls at the Brandon Road Pool of the Illinois Waterways, Des Plaines River, Joliet, was awarded in May for $237,772, about $98,000 under the engineer's estimate. There were 28 bids submitted. Following are unit prices of main items as submitted by the three lowest bidders. Lt. Col. Dan I. Sultan, U. S. Engineer Corps, is in charge. (A) Tulley-Costello Co., Chicago, contract; (B) United Construction Co., Grand Rapids, Mich.; (C) Fuller Construction Co., New Orleans.

Item	Quantity	Unit Prices (A)	(B)	(C)
Excavation, common, cu.yd.	19,000	$0.50	$0.40	$0.45
Excavation, rock, cu.yd.	15,000	1.20	2.00	1.75
Channeling, sq.ft.	65,000	.40	.50	.55
Grout holes, lin.ft.	5,000	.20	.30	.15
Backfill, cu.yd.	13,000	.40	.25	.40
Concrete, cu.yd.	25,000	6.72	6.35	6.65
Reinforcing steel, lb.	120,000	.03	.05	.03
Structural steel, lb.	4,500	.08	.08	.10
Iron castings, lb.	1,500	.08	.05	.05
Steel sheet piling, lb.	9,000	.05	.08	.04
Total bid		$237,772	$248,538	$251,568